



THE
NAVIGATOR

Shewing and explaining all y^e
Chief principles and parts
both *Theorick & Practick*, that are
contayned in the famous Art of
NAVIGATION.

WITH

A new and Admirable way of Sayling
by the Arch of one of the greatest
Circles.

Contayning excellent Tables most exactly
Calculated, shewing the true Proportion of
all Paralels in respect of the Meridian.
With the proper Phrases vsed in Work-
ing of a Ship according to all Weathers.

By Captain Charles Dalton Hall.

London. Printed for Geo: Hurlock. 1636



40. 50. 60.
80. 200. 120.
160. 200. 240.
700. 400.

3. 4. 5.
6. 8. 10.
12. 16. 20.
24. 32. 40.

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W. Marshall sculpit.



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And are to be sold at his Shop at St. *Andrews*-corner.

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* Nihil dictum
quod non dictum
primo.

*Fortuna fa-
vit faul.*

* senex vulpes
band capitur
laqueo.

For to find fault and shew no cause, none but vaine fooles will doe.
The Author is no *Galenist* that speakes but what hee's taught,
Nor doth hee sell those wares againe which he before had bought.
But from his owne Experience hee doth conclusions make,
And what he gives you approv'd you may for curiant take :
Hee dearely got what now he gives to all list list to reade,
Expecting naught in lieu thereof but labour for his meed :
Then take in worth what he so gives, you have it too good cheape,
He till'd the ground and sowed the seed, but you the harvest reape,
Thus much I have (to gratulare the Author of this Booke)
Thought good to write, and for my part so much content I tooke
In reading of his Manuscript before to Presse it came
That for his due no lesse I could then thus applaud the same.

[illegible]



TO
THE RIGHT HONORA^{ble},
THOMAS,

Earle of ARVNDEL and SVRRY,
Lord High Marshall of England,
Knight of the Noble Order of the
Garter, and One of his Majesties
most Honourable Privie
Councell.

RIGHT HON:



When a right Noble disposition is once generally discovered, it emboldens men that are meere Strangers, to presse into theyr presence, provided theyr errands are onely concerning vertuous Actions, which motive hath made these rude lines voyd of all Rhetoricke, runne with such hast to your Lordships hands, intreating for a favourable acceptance of a

The Epistle Dedicatorie.

few experimentall Conclusions, performed in the admirable Art of *NAVIGATION*, by one that is as much a stranger to your Lordship, as I am to the Land and my Kinsfolkes; many long Voyages having banished me from the remembrance of them both; so that I may justly affirme, I am scarce knowne to cyther of them, except now by reading my Name, they rub up theyr remembrance and finde me revived; who have layne a long time rak'd up in the embers of oblivion. Howsoever it happen in that respect, it is a matter very indifferent to my mind; for I onely desire, that these my Practices may prove pleasing to your Lordship, which although they are delivered in a blunt phraise, I assure you (*Right Honourable*) will speake the plaine Truth, otherwise they should not dare to desire such Noble protection, if they could not deserve and merit that which is most esteemed amongst vertuous mindes. Therefore I doe in a manner assure my selfe they will gaine Your good aspect, which is too great a reward, to let fall upon the first borne of my braine, and so will bind me perpetually to study, how to illustrate my present performance, that it may ever gaine Your Honours goodwill.

*Your Lordships, to Command
in any service:*

CHARLES SALTONSTALL.



TO THE READER in generall.

READER,



If thou hast ever runne over any of Neptunes rowling Empire, I know thou wilt not expect that smooth Rhetorick should flow from those rough imployments, upon which rugged Superficies all my particular Art onely claimes to have gained her originall. Having beene there soundly and sufficiently instructed by Industry and Experience, the two most excellent Tutors which teach the truth by tryall; and therefore those experimentall Practises which produce credit to the Theoricke through reall and uncontrollable Conclusions, must needs of all others bee most Authenticke. For no man must imagine to merit the Name of a Navigator, that can doe nothing out of his quiet Study, although in that place hee should be the most excellent and acute of all others; yet I say the Sea will so shake such a Professor, that there hee shall not be able to performe any thing, which plainly expresseth that the most deserving Navigator must have the two Noble Si-

To the Reader.

flers, Art and Experience ever wayting upon his perfecti-
ons, otherwise he will faile the Worlds expectation in giving
a true accompt of those Actions. Therefore I trust in the
whole tract of my following Treatise, thou shalt trace them
like loving Companions, which both together mount, first
the lowest Staire, and so inseparably proceed, untill they are
percht upon the highest Pinnacle; which place (thou mayest
understand) is obtayned with much paines, and cannot bee
purchased as one payment; because this excellent Art at each
degree of ascending will accept of no assurance save present
satisfaction, by which shee onely observes your sufficiency.
Therefore you must resolve to pay for each particular, as you
proceed, not presuming irregularly to aspire such unparalleled
perfections, least in the roome of your undeserved renowne,
you feele the sharpe lash of ruine, as a iust reward for such
rash attempts; yet I assure my selfe there are some Critticks
which will causlessly condemne and carpe at my following
Worke in the first foundation, as being layd too low; and
therefore none of it worthy to be look'd upon: Such bubble-
braines I leave to build brave Castles in the ayre (utable to
their empty out-sides, desiring to receive my generall Cen-
sure, ioyntly from the iudicious Sea-man and the intelligent
Artist, from whose favourable construction I expect my
Fortune, and so farewell.

Your Friend,

Charles Saltonstall.

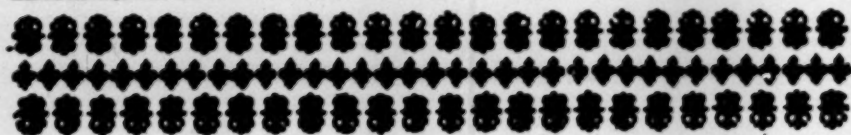
TO ALL GENEROVS AND industrious SEA-MEN.

Kind Companions :

I Could not chuse but present these few lines to your favourable acceptance, before you proceed to take a farther view of the following Worke, that none might hereafter mistake my intent, and imagine where Ignorance is openly pointed at that I meant any of you in particular : For Industry and Art, are both sufficient Bucklers to shield you all sure enough from any such danger. But you know there is a certaine kind of Creature, crept into the confines of most warlike Ships, whose rare and illiterate Allegations are ever absolute against the Rules of Art, and all those which bring about their Conclusions according to such Directions ; because they are cleane contrary to their constitutions. If such men as they snuffe up Pepper, and so fall a sneezing out their malice against the matter, which in no wise they are able to mend, the distast will give mee no discontent ; for their palates cannot relish the excellent rules of Reason ; therefore, I am certaine will suck out nothing but the sowre sauce, which will make them vomit up their venome, bequeathing all the rest to the intelligent Artists, men of another temper, whose tastes are able to distinguish what variety of delicate faire Fruits they are freely feasted withall. Their goodnesse I doe not doubt, but time will so well discover, that some gratefull acknowledgement shall bee powred upon the first Planter ; howsoever it fortune, I doe not desire to find favour through a flattering Epistle, presuming the ensuing matter must merit that, or else I have much mistooke the marke, and tooke a great deale of paines to little purpose. So farewell.

Yours, how you will,

Charles Saltonstall.



*In laudem Arithmeticae, & Navigatoris Arithmetici, a CAROLO
SALTONSTALLO delineati.*

Est Numerus proprium rationis, namq; propago
Caelestis mens est, retinens & originis alta
Obscurum Lumen, Numeri quasi Lampade lustrat
Mundum, sed Numerus nescit qua debita laus est
Hic sibi, nam solum numerando hanc illa fatiscit.
Nam Numerus species rerum, motemq; figurat
Antiquam induta forma, quia cuncta creantur
Ordineq; & Numero, speculoq; videntur in Artibus.
Ars Numeri Oceanum, Thetidisq; cubilia spectat
Atq; superficiem caeli mensurat, & omnes
In Sphaeris stellas, si qua vertigine certa
Per binos cursus remeant, iterumq; novantur;
Dividit hac terras, & tum Geographia pulchra est
Caruleum notos per Rhombos dividit aquor.
Protinus ut Numerus sese transformat ad omnem
Formam, subiectiq; figuras induit ille
Ut vestem externam; Numero Duce per mare latum
Nauta, etsi fueris ventis & fluctibus actus,
Oceano tandem emenso aspicienda resurget
Terra, atq; Ars Numeri ad Portum te ducet apertum.
Sed quorsum hac? Numero tuus hic Nauclerus in altum
Oceanum penetrans, Artis circumvolat alis
Circuli & hic Aren, Naucleri dirigit Artem.

Wyc Saltonstall.

In Praise of Arithmetick, and the Arithmetickall Navigator,
written and delineated by Captaine CHARLES
SALTONSTALL.

Number is vnto reason a property
For the Soule is a heavenly progeny,
Which still retayning some dimme obscure light
Of her so high descent, doth by the bright
And shining Lampe of Number the world view;
Yet Number knowes not what Praises are due
Vnto it selfe heere, but doth sayle therein
When it endeavoureth to number them.
Number did figure all the kinds that be
And gave forme to the Chaos formerly.
All things in Number have created beene
As in the Glasse of Art they may be seene.
This Art surveyeth *Thetis* bed, the Seas,
It measures the Heavens superficies,
And all the Starres, which in their Spheares move on
With a constant double revolution.
It divides the Earth, then 'tis Geography
And by knowne Rhombes divideth the blow Seas
Number like vnto *Proteus* doth turne
It selfe into a divers shape and forme;
And like an vpper garment doth put on
The figures which to his subject belong.
You Mariners, if Number be your guide
Though you about the Sea so broad, and wide,
By stormy windes, and waves have driven beene,
The shore at length shall swell vp to be seene,
And having past the Seas, Number shall bring
You to the Haven you desire to winne.
But what of this? Thy Navigator heere
Vpon the wings of Art it selfe doth beare,
And by the Arch of a Circle doth impart
To Navigators, Navigations Art.

Δίσταλον.
Ναυκληρὴ τέχνη μὲν ναυπλῆς ἐπιδεικνύται,
καὶ τέχνης ταύτης ἐστὶν ἀναξ Κατεργολός.

WYE SALTONSTALL.

In.

*In laudem CAROLI SALTONSTALL, & Navi-
gatoris sui. O'ydawyeu.*

Difficile est aliquem subito prodire Poetam,
Me vestram in laudem scribere jussit Amor.
Obsequium indignos laudet cum divise vena,
At laudem ex scriptis te mernisse liquet.
Omnia sal sapit, & super omnia spargitur hic Sal,
Artem & Iudicium pagina quaq; sapit.
Hinc Saltonstalli nomen tibi convenis, Artis
Spargitur, ecce tuo, sal super omne, libro.
I. F.


*In Praise of Captaine Charles Saltonstall, and his
Navigator, an Ogdoastick.*

TIs hard for any straight way to come forth
A Poet, yet Love bids me praise your worth;
Flattery may praise those that unworthy are
Of praise, but your Worke doth your praise declare.
Salt savours all, heere Salt on all is cast,
Each lease of Art and Iudgement too doth tast,
For you have sprinkled Arts *Sals-on-all*,
And so deserv'd the Name of *Salsonstall*.

I. F.

Old Father *N O N*, with all his saved brood,
Did first in Ship sayle on the Ocean flood:
And after that dividas the then knowne Earth
Into three parts, as his Sonnes right by birth.
But now behold a fourth more rarely blest
The Navigator, whose Art gain'd the rest.

RICHARD LYDALL.



3

WHat shall wee give the *Navigator* heere;
For Bayes too meane an offering doth appeare:
Although that Bayes and Rosemary both be
Vsed to grace a Bridall commonly.
You Saylers all pray come to the wedding
Of Art and Experience, with this bidding:
If for the Wedding-house you chance to looke,
The Wedding is kept heere within this Booke.
Then come you merry Lads, that have beene tride
And leave your Wenches, make this Booke your Bride.

Edward Blake.

**The Author to his Friend honoured
for Vertue.**

Ut stella in tenebris sic Amor in adversis.

NO time Deare Friend, can make your love appeare,
Like the dim Inscription of a Tombe-stone where
Each dusty letter is worne out, for I
Have on my heart ingrav'd your curtesie,
Comforting mee when I was most cast downe,
As a Trophie of fortunes unjust frowne.
Right gen'rous was your kindnesse unto me,
No time can wipe it out of memorie.
So that unto your Altar I will bring
Every day thanks for a free offering,
And will be onely thine, in any thing.

C. S.

To the merry *Marriners*, and *Sea-men*, the *Navigator*
wisteth *Health*, *Happinesse*, and *Prosperous*
Voyages.

YOU trusty *Trojans*, and you merry *Greekes*,
That doe ransack all the worlds *Coasts*, and *Creekes*,
The *Navigator* wisteth you all health,
And that you may bring home great store of wealth.
Which to performe if you advice will take
That all prosperous *Voyages* you may make
Hee shewes the way, that so you may come home
In due time to your *Wives*, who make their moane
Like chaste *Penelope* for her *Vlisses*,
Or like *Niohe* turne to *Stones*, but if wishes
Or the *Navigators* Art can prevayle,
To come backe to your *Wives* you shall not fayle.
And when you suddenly take them *Napping*
As they doe spinne on their wheelles at *Wapping*.
First give your *Wives*, I pray, a hearty *Smacke*,
Then drinke the *Navigators* health in *Sacke*.

Edward Flowerdew.

*Faults of the Presse; my Pen doth thus amend,
The Rules of Art in person I defend.*

PAGE 4. line 22. read *digression*, pag. 28. l. 8. for *frustrated* read *subtracted*,
pag. 5. l. 35. leave out *or*, pag. 69. l. 3. read *their true distance*, pag. 76. l. 4
for *A*, read *B*, pag. 78. the circular Figure wanteth *G*. pag. 95. put in *my*, in the
manner of worke of the 2. *Quest.* of *Reduction*, read 13. *deg.* 12. *leag.* 2. *mil.*
63. 1. *Staves*, pag. 98. the fourth *Question* is to be wholly left out, for the 5.
Question is the same shewing the true manner of worke, pag. 102. l. 12. read
45. 29. *leag.* 0. *mil.* 360. *Staves*, pag. 106. l. last, read 462912. pag. 107. l. 2.
read 154. *leag.* 0. *mil.* 912. *Staves*, pag. 108. l. 7. for *know* read *now*, pag. *ibid.*
l. 8. for *with you how to reduce*, read *which reduce*, pag. 111. l. 27. read 60. *deg.*
pag. 113. in the *Quest.* of the *Reversed rule*, for *ridge*, read *rigge*, for *Lye* in the
last line of the booke, read *like*.



THE NAVIGATOR.

(*)

CHAP. I.

*The Division and Description of the whole Art
of Navigation.*



Navigation is that admirable Art which produceth most certain and infallible Directions, how you shall layle a Ship the most compendious Course betwixt any two places that are never so farre distant, if there bee Sea or water sufficient for the Ship to swim through: which knowledge is gained by getting the true understanding of these two principall parts; Namely the Theorick, and the Practick. For the Theorick will fully informe you of the composition of the Spheare in generall, and in particular of the Figure, Number, and Motions made in the Heavens, chiefly of the highest moveable, called (*Primum Mobile*), and likewise of the first, fourth, eight, and ninth Heavens; the Theoricke will also informe you how the Elements are disposed, with their quantities, and situations, especially in
B the

the composition of the Earth and Waters, which make one absolute round body, with the Nature and use of the Circles which are supposed to be contained in that Spheare; if you doe not endeavour to get this knowledge, you cannot desire the name of a Navigator. The Practick part is properly placed upon the making and using of divers Instruments, as Crosse-staves, Back-staves, Nocturnals, Planisphaeres, instruments for the Moone and Tydes, with divers others: Yet there is one certaine Composition more rare then all the rest in the Practick of Navigation, which hath ever beene omitted by all men that have writ of the Art: And that is, the unparralleld Fabrick, of a gallant Ship, whose way of working, ruling, guiding, governing, and constraining to performe the expert Navigators pleasure in the Sea, hath at no time untill now beene explained by any Pen: But I could not let it passe any longer, because I knew with proper phrase how to performe it, which perchance hither unto hath hindred it from the publicke view, howsoever it hath happened I know not, but me thinks the divers Navigators which have writ severally of the Art, should some of them have remembred before this time to try, how truly and lively they could have layd forth their Skill in controlling, guiding, and working a Ship according to all weathers at Sea, by the expression of their pen: but I trust they will all pardon me for taking notice of their over-sight, if they will not, I assure him that thinks his selfe the most sufficient, that I doe not feare hee should draw forth a second description to make the Matter appeare more Lively in a lesse Compasse.

CHAP. II.

The Practicke part of working a Ship in all Weathers.

FOR that part of Navigation which is performed by the practickall knowledge of working a Ship in all weathers at Sea, it is impossible for any to prescribe rules, or give demonstration by words to those which are altogether ignorant of Marine affaires that they may reape any benefit or knowledge by it, although indeed, that whole Practick part may be composed and delivered in proper Sea phrases according to each severall materiall belonging and appertaining to a Ship compleatly rigged, with the use of each severall Rope in working and trimming sailes at Sea; But I pray, who would or could possible apprehend the reason of such a demonstration except an experienced Marriner, who will give you as little thank for your labour in taking paines to advertise him of those things which all his life time he hath bin brought up to, as if you should go aboard a Ship and shew the Master which is the Mayne bowlyne; but because all Arts and Sciences, are diuided into two chiefe parts or principals, namely the Theorick and Practicke, and in regard it is impossible, for any to be compleat without hee hath attained to the true knowledge of them both, (being inseparable companions which ever waite upon perfection.) Therefore I could not now command my pen to passe any further forward, before it had first plainly expressed the proper way of working a Ship in all Weathers, that it might prevent the censure of all such, as I am certaine will be very curious in inquiring, whether I may not be found lame in that Limbe, and so like themselves should appeare most imperfect. (For with grieve I speake it) this Noble Art of Navigation had never more maimed and decrepped fellows (preferred through fauour and fortune) so that now

adayes let one come aboard a tall Ship at Sea, and it wilbe very rare to find ignorance out of the bound-house, but commonly better Marriners and more sufficient men afore the Mast, which are turned Hawke-Bowlinge through the avernesse of their fates, I should be very glad to see a more equall Ballance used, for the furtherance of the industrious and encouragement of deserving men; For, if this Insufferable partiality should be of any long continuance, I feare in short pericoll of time, the compleat Marriner will very hardly be found aboard any Ship, although you search, Fore, and Aft, to the great dishonour of this Famous Ile, which hath so long deservedly held the superiority of all other parts of the whole World, for breeding and bringing forth Famous Navigators. The *Hollander* already beginneth to have us in Contempt, saying, he is farre afore us; both for Ships and sufficient Marriners; but for the last, it may be soone answered, had not the former unequal ballance, enforced our expert Saylers to seek if Fortune would be more favourable amongst them, they had not bene at this day in such a flourishing height; but swift time is subject soone with his silent course to steele us out of remembrance, and so I doubt they will exceed us indeed, to our Nations great dishonour. I will not draw forth this digression to any longer discourse, least my Rhetoricke should not relish in the Eares of all men, but will now returne, to this Practick part formerly expressed, that it may appeare in proper Sea-phrases, how a Ship compleatly Rigged, should be worked both by and large in faire weather and Foule, not expecting that any may reape knowledge by it, but onely that Marriners may censure, for some I know being a little touched will say (as their common phrase is) if they had me at Sea, and turned me three times round, all my prescribed rules would be to seeke, but let them know (no) not if they turnd the Ship threescore times round, and let it blow-high, blow low, but I will worke the Ship as well in all assayes as ever they did, therefore to prevent such calumnie, let all men consider this Practick part, in brieve following.

My

The Navigator.

8

My Anchor is away.

THe wind is Roome, let fall your Fore-sayle, heave out Fore-top sayle, heave out Maine-top sayle, hoise up Fore-top saile, hoise vp Maine-top sayle, loose Sprit-sayle, heave out Mizzen-top sayle, square your Sprit-sayle, a brave gale, let vs have her in all her Canvass, heave out Sprit-sayle, Top-sayle, Fore-top-gallant-sayle, Maine-top gallant-sayle, boyce up your smali-sailes, hawle aft your fore-sheets, I keepe my Mayne-saile furled, because I hold it your Fore-saile and Fore-top saile be good Sailes, that the Ship maketh better way now, then if her Mayne-saile were downe, which would becalme her Fore-saile, and Fore-top-saile, and the Ship steereth best with her head-sailes. I have of purpose omitted the cleering each severall Rope, now at my setting saile, onely you must Imagine, that the Sheats are all hawled-home, and the yards hoysed up, and then you have her compleat, under-saile right affore :

A fresh Gale.

THe wind bloweth Fresh, hawle downe your Fore-top-gallant-saile, hawle downe Maine-top-gallant-saile, In Sprit-saile-top-saile, let goe Sprit-saile-top-saile. Sheats, hawle home his Clulynes, In Fore-top-gallant-saile, In Main-top-gallant-saile, In Myzen-top-saile, let goe Top-gallant Sheats, Cast off Top-gallant bowlynes, hawle home Top-gallant Clulynes, the Mizzen Top-saile is In, and so is all the rest of the small sailes.

A Scant-Wind.

THe Wind Scanteth, veare-out some of the weather Sheat of the Fore-saile, let goe your weather Braces, top
B 3 your

your Sprit-saile, loose Mayne-saile, (the wind vereth forward) get too your Fore-tacke, cast off your weather-Sheate, let goe your weather-Brace, vere out some of the lee-Sheate, let fall Maine-sayle, get too Maine-tack, cast off Maine-brace, and Maine-top-sayle, hawle aft Maine-sheate, the winde is Sharpe, in Sprit-sayle, square Sprit-sayle-yard, let goe Sprit-sayle Sheates, hawle vp Sprit-sayle Clulynes, get Maine-bowlyne, in Block, hawle forward Maine-bowlyne, hawle Main-top-sayle Bowlyne, hawle tought, Fore-bowlyne, and Fore-top-sayle Bowlyne, hawle aft Maine-sheate, hawle abroad Myzen, set in your Lee-braces, and keepe her as neere as she will lye; heere you have all your sayles, Trim'd Sharpe or by, a wind.

A Stiffe-Gale.

THe wind blowes Frisking, settle downe your Fore-top-sayle, settle Maine-topsaile, (much wind) hawle downe Fore-top-saile, hawle downe Maine-top-saile.

A hard Gale.

IT bloweth hard, take in our Top-sailes, let goe your lee-Braces, and cast off your Bowlynes, brace your Weather-Braces, and spill your Sayles, let goe Top-saile Sheats, hawle home Top-sayle Clulynes, the sailes are furled, square your Top-saile yards; heere have you the Ship brought into her courses or low-sailes.

A Storme.

IT bloweth extreame, and like to overblow, see that your Maine-Hallyards be cleere, make all your geere, cleare to lower the Maine-yard, hawle downe the Myzen, cast off Top-saile Sheats, Clugarnets, Buntlynes, Leechlynes, Lifts, and all your other geere, (and Lower) bring the yard downe, hawle
to

to the Capsten, the yard is downe, get the Saile together, and Furl it sure, make fast the yard for Traversing.

A growne Sea.

THe Sea is much growne, we make foule weather, looke our Gunnes be all fast, it is better Spooming, put the Helme a weather, and mind what is said, right your helme, let rise Fore-tack, settle our Fore-yard, the Fore-saile giveth way, (lower a Mayne) hawle the Saile into the Ship and loose it from the yard, get too the Fore-Bonnet, make all cleere and Hoyse the Fore-yard; heere have you the Ship, brought from all her Canvas to a Fore-bonnet spooming before the Sea.

A fierce Storme.

STarbord, Hard up, Right, Port hard, more hands (he cannot put up the Helme) the Sea breakes dangerous, have a care what is said, and stand stoutly to the Helme, shall we get downe our Top-masts, no let all stand, the Ship is the hol-sommer, and hath better way through the Sea, for their being a lef, (if you have Sea-roume, it is never good to strike your Top-masts either under the Sea or before;) thus much for handling the Ship By and Large, in Faire-weather and Foule; now a word or two, of Turning to Windward.

To turne to Wind-ward.

MY Course is N. and the Wind is at N, E. get your Star-board-Tackes aboard, cast off your weather Braces) brace upon your Lee-Brases, and hawle forward by your weather Bowlines, hawle tought all your weather Bowlynes, and set in your Lee Brases, hawle abroad Myzen, and keepe her full, and By, as neere as she will Lie. *How wind you, N, N, W. aquade winde (no Neere) hard no neere, the wind*
veareth

veareth forward, we shall have a Westerly wind, *How wind you*, W, N, W. hard no Neere, *How wind you*, S, W. (make ready to goe about) we shall lye our course the other way (*Ready, Ready*) no Neere, give the Ship way that she may Stay, (a Lee the Helme) veare out fore Sheate, cast off Lee-Brases of your Fore-saile, and Fore-top-saile, brase upon the weather Brases, (the Fore-saile is a Back Stayes) hawle about Maine-saile, let rise Maine Tacke, cast off your Lardboard Brases, let goe Maine Bowlyne, and Maine-top-saile Bowlyne, hawle forward by Larbord, Maine Bowline and Maine-top-saile, brase upon Starboard, Maine Brase and Maine-top-saile, get too Maine Tack, and then hawle aft Maine Sheat, let rise Fore Tack, veare out weather Sheate, get too Fore Tack, let goe Fore-Bowline, and Fore-top-saile, hawle aft Lee Sheat, hawle tought Maine Bowlyne and Mayne-top-saile, hawle tought Fore Bowline and Fore-top-saile set in Lee Brases, Fore and aft, and the Myzen shifted, keepe her as neere as she will Lye, no Neere, *How wind you*, N. and a weather, no Neere, keepe her full, the wind is at W. keepe her as neere as she will Lye. *How wind you*, N, N, W. no Neere, veare out some of the Maine Sheate, and ease your Lee Brases, keep your course, (the wind is broad) veare out some more of your Maine Sheat, let goe your bowlines, and Lee Brases, the wind is *Quartoring*, let rise your Fore Tack, hawle aft the weather Sheat abaft the Anchor Stock, brase upon your weather Brases, hawle up your Myzen and loose Sprit-saile, sa brave gale, the wind is all aft, let rise Maine-tack, hawle aft Maine Sheat, square Sprit-saile and all the rest of our Sailes; heere have you the Ship in all her Canvas againe, Steering right before the wind as she did at the first setting saile, Having beeng worked in all manner of weather, and with all sorts of winds. Therefore I will onely proceed concerning how the Man-of-Warre, ought to be worked, in all assayes, and so will leave you the Practicke to censure.

A Man of Warre.

Our Man-of-Warre is compleatly rigged, and fitted with all manner of materials, a choyce crew of Sea-men aboard, and now lyeth at *Hull* in a good Latitude, daily expecting that a faire Fortune will appeare within her Horizon. the day breakes, bravely (up youths into the Tops and looks abroad now at Sunne-rising.) looke to the Westward, if there be no plyers that are Nipt with this Easterly wind, (*A Saile, a Saile*) faire by us (how stands she) it is one that is plying to windward, she stands with her Larboard Tackes aboard, (O, then she lyes, to the Southward with the Steame, a brave Chase) wee see her here upon the Decks, set her by the Compass (how beares she) due S. W. a good man to the Helme, let fall Fore-saile, get Larboard tackes a board, downe Maine-saile, heave out Fore-top-saile, heave out Maine-top-saile, hoyce up Fore-top-saile, hoyce up Maine-top-saile, let fall Sprit-saile, heave out Sprit-saile-top-saile, out Fore-top-gallant-saile, out Maine-top-gallant-saile, hoyce up our small Sailes, hoyce up our Myzen, heave out our Myzen-top-saile, have a care of your hand at the Helme, (keepe her thus) well Steerd, the Ship makes brave way through the Sea, and we raise her a pace, if she keep her course wee shall be up with her within two glasses. (Starboard) keepe the chase open with the litch of the Fore-saile, well (Steered) keepe her thus, come aft all hands, the Ship will saile better by a Top-saile, for she is too much by the head, sit all still that the Ship may runne true through the Sea, it is a great Ship (no forte) shee hath the bigger hold, and carries more goods, (Port) the chase is a stayes, she will about the other way (Port) the chase is about (Port hard) let rise Maine-tacke, let rise Fore-tacke, brace upon your Larboard braces, get too Starboard-Maine-tacke, and Starboard Fore-tacke, cast off all your starboard braces, (steady) right your Helme (well steerd) the chase clings up close to the wind, keepe her open under our Lee, Gunner see that all

C

our

our Gunnes be cleere, and that nothing pester our Decks, for we shalbe straight up with her, (Starboard) the chase payes away, more roome (Starboard hard) veare out some of the Maine Sheate, and Fore Sheate, cast off all your Larboard braces, (steddy, steady) keepe her thus, well steerd, the chase stands roome, her Sailes are trimm'd before the wind, (Starboard hard) let rise Maine-tacke, let rise Fore-tacke, hawle aft Maine Sheats, hawle aft Fore Sheats, we have a Sterne chase, hawle up our Maine-saile in the Brayles, the Ship will steere the better with her head Sailes, and will have quicker way through the Sea, we fetch upon her hand going, the chase hawls up his Maine-saile and furles it, she puts abroad her waste cloaths, she will fight with us before the wind, (come up alow young men) and furle our Maine-saile, Sling our Maine yard, with the Chaines in the Maine-top, Sling our Fore-yard, put abroad our waste cloaths (is all things cleere below) leave not so much as a Spun yarne amongst our Gunnes, downe with all Hammaccoes, and Cabbins that may hinder or hurt us, Gunner have you all your geare in a readinesse, is there store of Cartrages ready fill'd, all manner of shot at the Mainemast, Sponges, Rammers, Ladels, Primming Irons, and Primming hornes, Lyntstockes, Wads, and water sufficient for the severall Quarters, be sure that none of our Gunnes be cloyd, and when we are in fight, ever load with Crosbar and Langrell, alwayes observing to give fire when the word is given, see that there be halfe Pikes and Javelings in a readinesse, and that all our Martherers and Stockfowlers, have their chambers filld with good Powder and bagges of small Shot to loade them, that if we should be laid aboard we may cleere our Decks, we are almost up with our chase, she is full of men, it is a hot Ship, but she is deep & very foule (come cheerly my hearts) it is a Prize worth fighting for, the chase takes in her small Sailes, up aloft youths, take in our Top-gallant-sailes, in Sprit-saile-top-saile, in Mizen-top-saile, take in our Sprit-saile, & bring the yard alongst-Ships, she puts abroad her colours, it is the Ragged Staffe, boy up & put abroad *St George* his

his colours in our Maine-top, step aft a hand, and put abroad our bloody Ancient, she settles her Top-sailes, we are within shot, let all our Gunnes be loose in the Tackles, and the (Ports) all knockt open that they may be runne out when the word is given, up Trumpet and haile our Prize, she answereth us againe with her Trumpet, hold fast Gunner, doe not give fire untill we haile him with our voyces (Port) edge towards him, he fires his broad side upon us (what cheere my Mates, is all well betwixt Deckes, yea, yea) onely wee are rackt through and through, (no force) it is his turne next, but give not fire at any rate untill we are within Pystoll shot, (Port) edge towards him, he plyes his small-shot, hold fast Gunner (Port) right your Helme, we are close aboard (Starboard) give fire Gunner, answer him in his owne Language, he gaules us with his small shot, Gunner clap in some case shot into those Gunnes which you are now a loading, we are shot a head, he lyes broad off to the Southward, that he may fire his other broad side upon us, (Starboard hard) get too Larbord Fore-tacke, trimme your Top-sailes, runne out our Larbord Gunnes, he fires his Starboard broad side, upon us, and powres in his small shot (Starboard) give not fire untill the fall off, that the prize may receive our whole broad-side (Steddy a Port) give fire Gunner, his Maine-top-mast is by the board, and our last broad side hath done great execution (cheerely my Mates, the day will be ours) he is shot a head, and beares up before the wind to stop his Leakes, (keepe her thus) well Steer'd, wee are to the Southward of the Prize (Port hard) beare up before the wind, that we may give him our Starboard broad Side, Gunner is there good store of Case shot in our Gunnes (yea, yea) Port) edge towards him Gunner when you give fire, bring your Gunnes to beare amongst his men upon the Deckes, that they may share our case-shot, (well keerd) we are close aboard, give fire (Starboard) well done Mr. Gunner, they lye heads and poynts aboard the chase, we are shot a head, he strikes his Fore-top-saile, he would fall a Storne, he hath his belly full, but wee

must not leave him thus, aluffs into the wind, he braces his Fore-saile and Fore-top-saile a Backe-stayes, (Port hard) get too Starboard Maine-tacke and Starboard Fore-tacke, (aluffe) hawle forward Maine Bowline, and Maine-top-saile Bowline, hawle forward Fore-Bowline and Fore-top-saile Bowline, (aluffe, aluffe) well steer'd (no neere) come ready, ready, that we may goe about, we shall fetch her againe upon this board a Lee the Helme, the Fore-saile is a back-stayes, let rise Maine-tacke, let goe Maine-bowline and Maine-top-saile Bowline, hawle about Maine-saile, get too Maine-tacke, and Fore-tacke, hawle aft your Mayne-Sheate and Fore-Sheate, trimme your Top-sayles (no neere) hard no neere, the Ship will stay, flat in your Fore-saile shee falleth off againe (thus) (warre, no more) (aluffe) the prize puts abroad a white flag of truce, (aluffe) we will weather him, and then keepe him under our Lee, he hailes us with his voyces, mind what he sayes, (Quarter for our lives, and we yeeld the Ship and Goods) good Quarter is granted, (provided) that you forthwith take in all your Sailes and furl them, untill wee come aboard with our Shallop, if you unloose a knot of Saile expect our broad-side and no Quarter; thus leaving the Man of Warre, to enter his Prize, I will likewise leave you thus much of the Practick part of Navigation, to all your Iudicious censures, by which you may perceive, that I have turned and worked the Ship in all assayes, with words and proper Sea-phrases: And if I were at Sea, I should performe it both by word and deed. Therefore let not Ignorance, the arch enemy of Arts, deceive himselfe, and thinke that three times turning will turne my brayne, but that I will turne to windward with him for all his shooes in his Shop, and when I have done, will as easily turne him in the Theorick, which way I list, As I can the Ship with the Practicke.

Of the Compass.

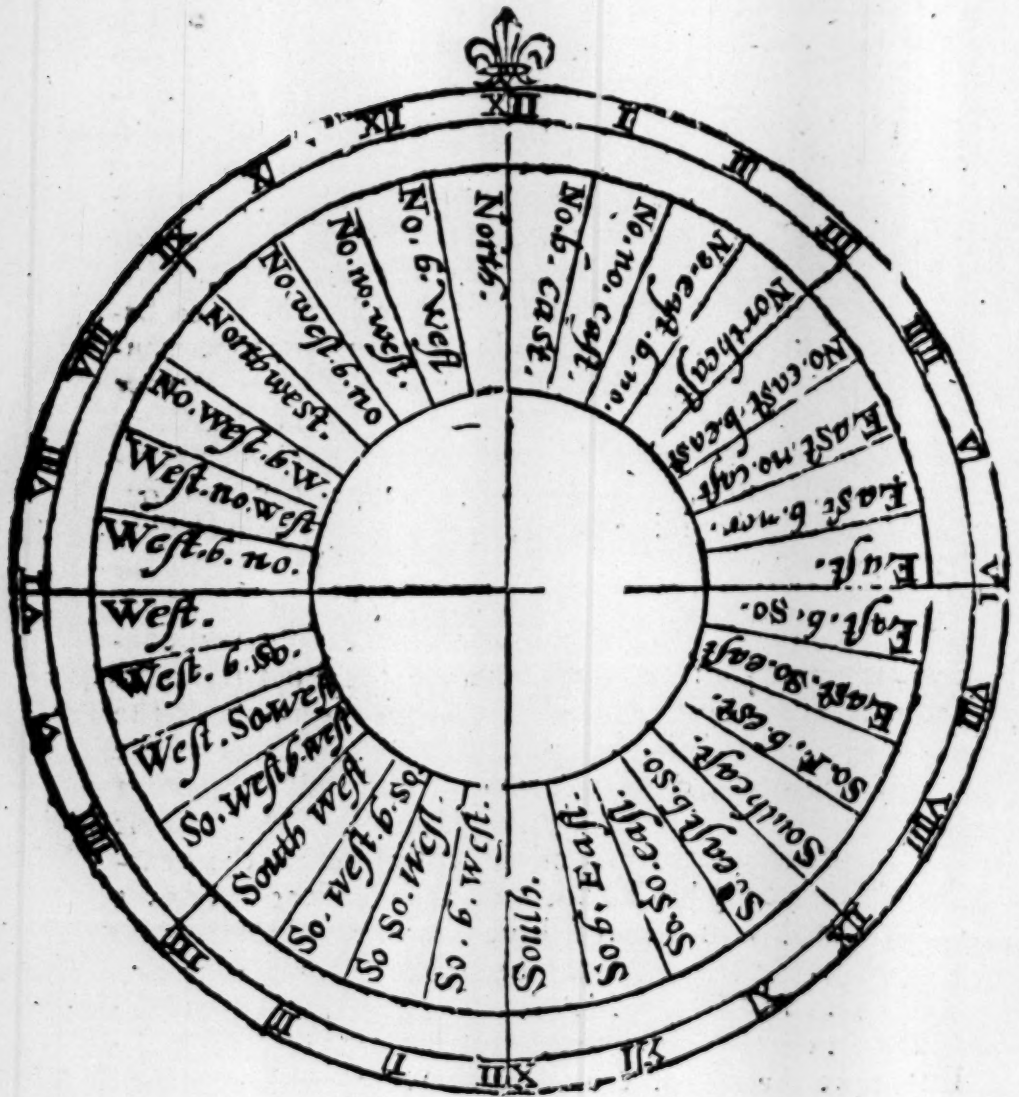
THe foure principall Handmaids that alwayes waite upon the expert Marriner, and crowne his Conclusions with everlasting credit, are these loving Sisters, *Arithmeticks*, *Astronomy*, *Geometry*, and the *Mathematickes*. By the operation of these excellent Arts Navigation is daily practised by some few expert Sea-men, but much more abused by many hundreds of Ignorant Asses, that know little of nothing what belongeth to any of them; yet will undertake to direct a Ship to any place upon the Terrestiall Globe, wholly trusting that favourable Fortune will make them famous, but oftentimes a disastrous period concludes theyr undertakings, with the lamentable losse of divers mens Goods and Lives; But to returne to the matter intended I would have it understood, that although I have named these foure Arts, as the originals of Navigation; yet that I doe not meane in this place to insist upon each severall Science in particular; for then I should increase my Discourse to a great volume, before I come to the purpose that I point at; Therefore it is supposed first, that hee which intendeth the Art of Navigation hath all manner of Arithmeticks in a readinesse, which if hee want, there are divers Bookes already extant that will instruct him, as namely, *Record*, *Baker*, *Blundivell*, &c. And for *Geometry*, *Speedels* Extractions, and *Digges* his *Geometry*, with divers others. And for the *Mathematickes*, and *Astronomicall* knowledge, so much as is necessary for a *Seaman*, will be discovered in the Projection, and use of divers Instruments of Navigation, which will hereafter follow in the ensuing Worke.

And now to proceed in a Regular forme, for the attayning the full knowledge of this famous Art, the *Sea-Compass* presents himselfe as the first principall, framed by the operation of the *Magnet*, which although it be a thing in respect of the quality beyond our Capacities; yet his use is

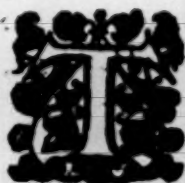
the first part that is necessarie to be understood, and must even be the foundation to all future conclusions, (As letters are to expresse Language) and may not unfitly be compared as a beginning, of the same nature, for first you teach your children to know the letters by name, and so in the like manner we teach our youths, and boyes (which wee intend to make Navigators) the poynts of the Compasse by name, reason as yet (being onely empty sound on both parts) then as you proceed to shew your Children the nature of joyning Letters, and making syllables of divers sorte and sounds, so we after the poynts are grownne frequent and common, teach them to joyne or spell, by shewing them how the winds bloweth, and demanding what poynt it cometh from, as likewise by setting the Capes of Land, and the bodyes situated in the Heavens, (as Sunne, and Starres,) and then requiring what poynt runneth with them; and now as Children which know their letters and syllables, attaine in short time to the reason of Reading, so our youths having once the 32. poynts of the Compasse as perfect in generall, as East, West, North, and South, are to all men in particular, will in short space conceive by what reason wee guide the Ship, and shape our Courses betwixt place and place. The Compasse which wee use to direct our Courses by, is onely a Circle of some 8. or 9. inches diameter, and is divided into 32. parts or Points, intersecting each other onely in the Center, and these Points have theyr severall denominations, as the Figure doth expresse the whole Circle which is divided into 32. equall parts or Points, (as is afore-mentioned) is likewise divided into 360. equall parts or Degrees; the Compasse also containeth 16. distinct Rombs or Courses, for each severall Course hath two of the poynts of the Compasse by which hee is expressed; as for Example, where there is any place that is situated South-west, in respect of another place, wee say, the Rombe or Course that runneth betwixt them, is South-west and North-east; if the place
beare

beare North, wee say the course is North and South; if East, we say, East and West, &c. Now the wyers being discreetly touched, and this plaine Superficies, or Fly playing, at the least motion upon his perpendicular pinne that beareth him upon his poyn in the very Center. The Instrument is compleat in his parts, and in the whole doth represent the Horizontall Circle, which you may see in any plaine Superficies, as at Sea where looking round about, the (Interfection which the Heavens maketh with the Waters) sheweth that you are in a Center, and that all places of the Horizon are of equall distance from you. Now this little Instrument of the Compasse, sheweth the same thing in small which you behold in great, and by reason of the excellent and supernaturall quality of the *Magnet*, which turneth the *Flower de Luce* ever towards the North, all the 32. Points of the Compasse directeth with the same truth according to their severall denominations, so that nothing can appeare within your Horizon, whether it bee Ilands, Rockes, Ships or such like, but you may straight looke upon your Compasse; and one of the 32. points will runne right with the object discovered, which according to the denomination of the point, wee conclude it beareth or is Scituated from vs; therefore it is most necessary, that all Navigators should have the points of the Compasse so exactly ingrafted in theyr mindes, that at the first sight in all assayes, there happen not any mistake, which may prove many times very dangerous, to the hazard of Ship and goods, with lives and all; therefore for the benefit of those young Practitioners, which perchance are as yet unacquainted with them, I have heere framed this Figure following, representing the Sea-Compasse with his 32. Points, and 16. Rombs or Courses, unto each of which I have annexed theyr severall denominations, signified by the Letters at the end of each severall Point; and thus much for the present concerning the Sea-Compasse as the first principall or part of Navigation, and not in this place to procted to the manifold Conclusions which are performed through

through his ayde and application, as will bee manifested hereafter.

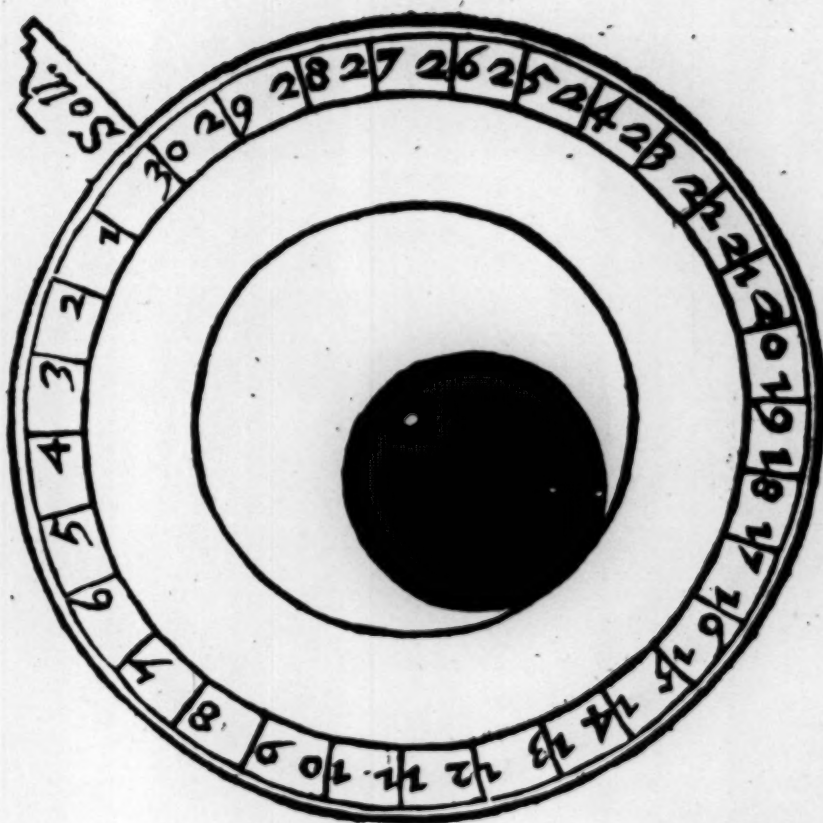


*The Ebbing and Flowing of the Sea, and the
Moones Motion.*

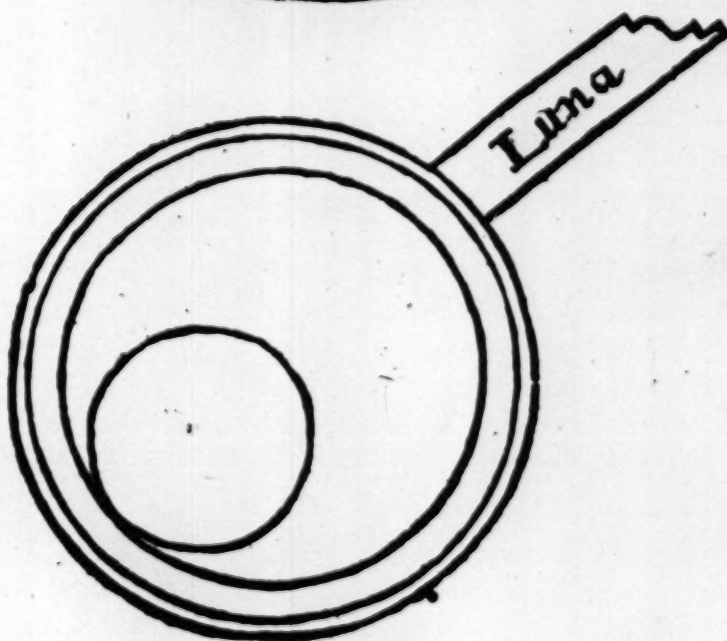


He next necessary to be learned in order by the Practitioner of Navigation, is to know the certaine time of the Ebbing and Flowing of the Sea in all Ports or Creekes, commonly called by the Sea-man, *The shifting of Tydes*; which by Experience is found to bee governed by the Motions of the Moone; therefore, I should shew you now in the first place, her severall Courses and when shee hath swift Motion, and when slow, but I will of purpose omit it in this place, because it will appeare more properly, where I shew you Arithmetically how to finde the Moones age, and what other Conclusions are to be wrought by Arithmeticke, which may bee, some of you that reads this Booke are not very expert in; wherefore, I will first shew the use of a small Instrument which I have heere framed, whereby the meanest Capacity shall bee able, not onely to know the Age of the Moone, with what Flood or Ebbe it maketh in all the Channell, and in every Port or Creeke, but shall likewise be able to know what a Clocke it is at any time of Night, and divers other Questions in Navigation, onely by moving the Indexes of the Instrument, according as the question shall require, which I will shew at large how it may be performed, and then I will likewise shew how it is to bee done by Arithmeticke; but first for your Instrument, it must bee projected according to the following Figure. For the framing of this Instrument, you must have three small pieces of boards well playned and exactly divided, according to the same manner as I have formed it in the Figure, the biggest of which boards having the 32. Points of the Compasse, and the innermost Circle containning 24. Houres, must be something

thing thicker then the other, the next Circle being devided into 30. equall parts, representing the distance of 30. times 24. houres or 30. naturall Dayes, is attributed to the Sunne; the other Circle, and the uppermost of the three, having nothing graduated upon it, is attributed to the Moone, and hath his Index to bee turned about as that of the Sunne, and may be turned or applyed eyther to the 30. Dayes, containing the Computation of time betwixt Change and Change, or to the 24. Houres, as likewise to the Points of the Compasse,; and so may the Index of the Sunne bee applyed, eyther to Time or the Points of the Compasse; which being made plaine by some Questions, will appeare both delightfull and most easie to bee attayned unto, and I hope the illiterate man will finde it most usefull, and likewise, hee that hath some better knowledge and can tell how to conclude these easie Questions by other meanes, will sometimes use this Instrument for variety sake. I will now first draw the Figure, and then will propound some certaine Questions to make the Instruments uses appeare, as the Worke following manifesteth.

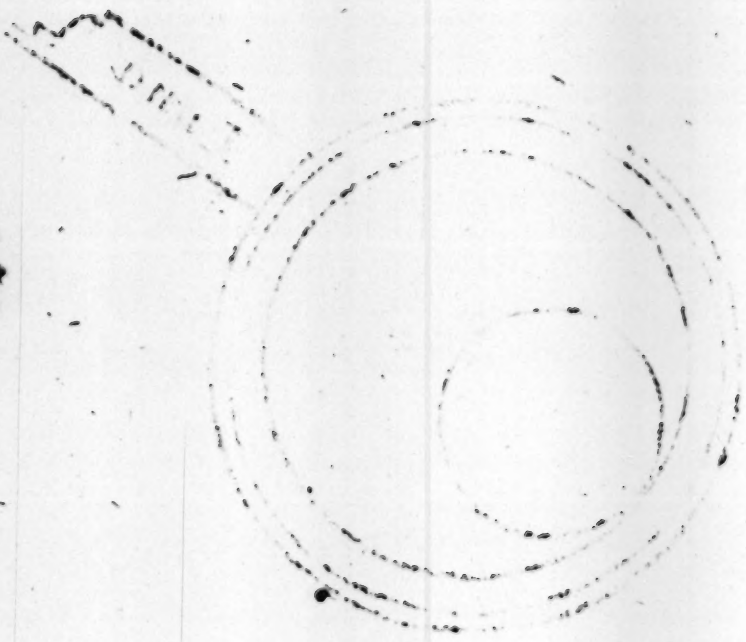
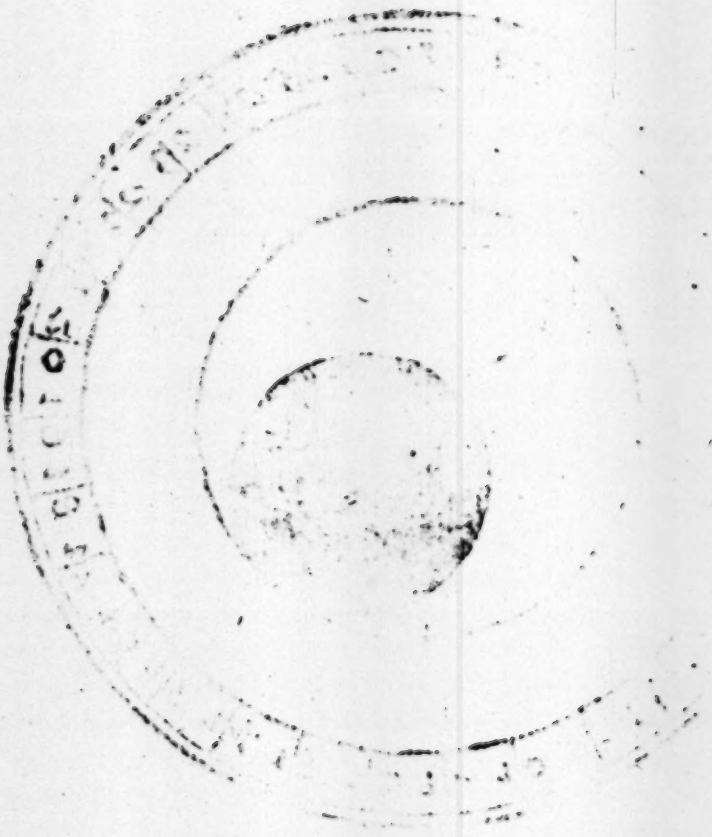


Cut out both these Types, and place them upon the next
Figure following, first *Soll*, and then *Luna*.

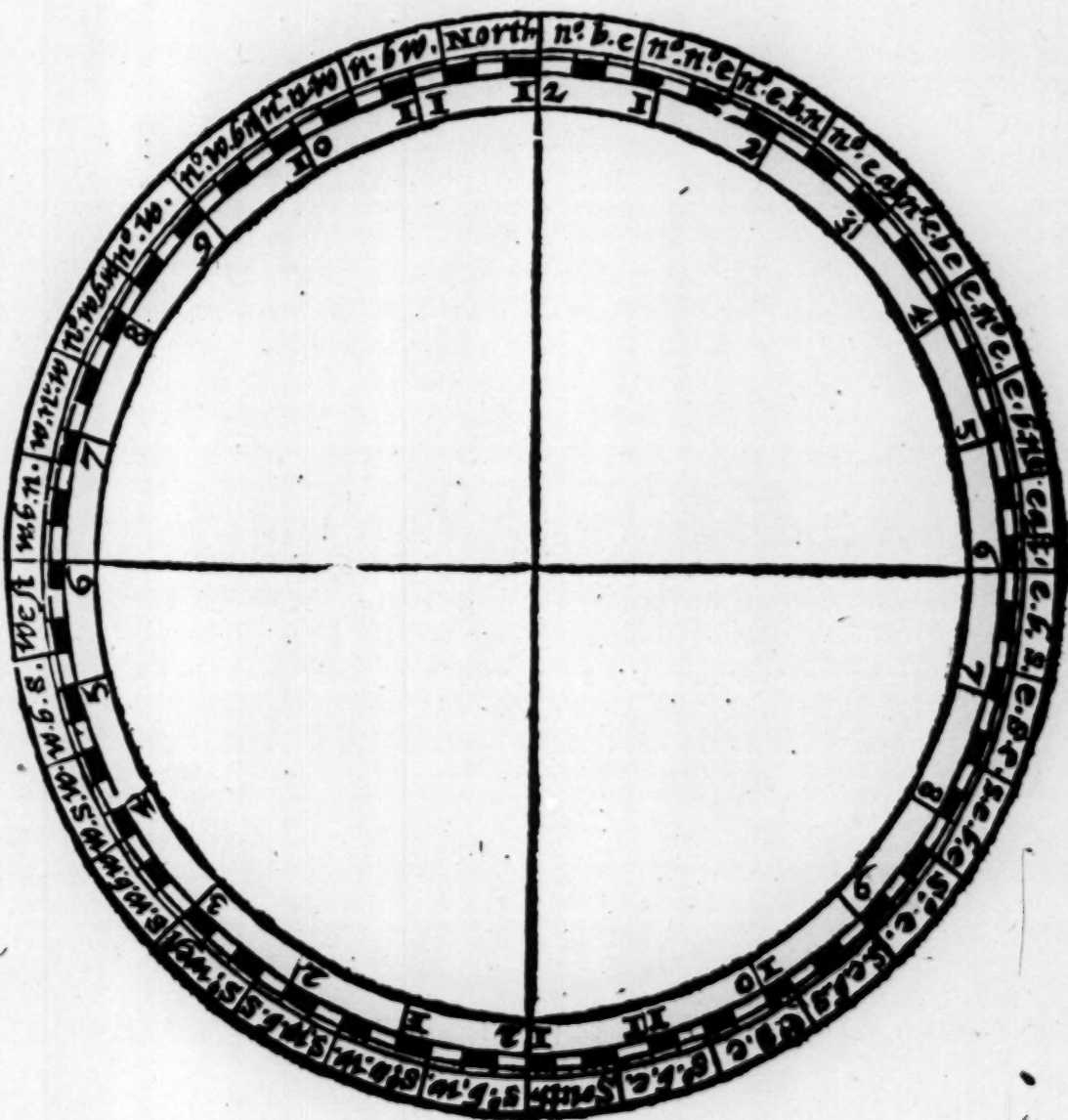


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The Instrument or Work.



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First

First Question.

THe Moone being 20. Dayes old, upon what Point of the Compasse shall she be at 10. of the Clocke at night.

You must note in this question, that the houre of the Day and the Moones age is given, and that to answer the question, you are to finde the Point of the Compasse, which shee will be upon at that instant; therefore place the Index of the Sunne upon the Compasse at the houre 10. of the Clocke at night, then bring the Index of the Moone right over the 20. day of her age, which is graduated upon the Circle of the Sunne, and the Index of the Moone will poynt in the Compasse East, which is the true place of the Moone, and answereth the Question required.

Second Question.

THe Moone 20. Dayes old, I demand what a clocke it is when she is upon the Poynt. E. S. E.

In this Question, you have the Moones age and the Point of the Compasse given, to find what a Clocke it is; therefore turne the Index of the Moone untill you have brought it to the Poynt, E. S. E. and there hold it steady untill you bring the 20th, day of her age right under the same Index, and then the Index of the Sunne, will shew that it is 11. $\frac{1}{4}$. at Night, which answereth the Question.

Third Question.

THe Moone being E. at 10. of the Clocke at Night, I demand how old she is.

In this Question you must consider, that you have the Poynt of the Compasse which the Moone is upon, and the houre that it maketh given, but you are to answer the Question, by finding the Moones age; therefore bring the Index of

of the Moone to the given Poynt E. and then turne the Index of the Sunne, untill you bring it right with the houre given, which is 10. of the Clocke at Night, and then observe what day the Index of the Moone cutteth, and you shall finde the 20th, which is her age, and answereth the Question demanded with truth.

Fourth Question.

THe Sunne being West, and the Moone East, I demand what a Clocke it is, and how old she is.

In this Question, you have onely the Poynts of the Compasse given that the Sunne and Moone are upon, therefore turne the Index of the Sunne due W. holding it steddy upon that Poynt, then bring the Index of the Moone to poynt due E. and you shall have under the Index of the Sunne in the Circle, containing 24. houres, 6. of the Clocke at night, and under the Index of the Moone, in the graduated Circle of her 30. dayes contained betwixt Change and Change, and you shall find 15. which is her age, and answereth the Question.

Fifth Question.

THe Moone being 15 dayes old, I demand what a Clocke it will be when she is upon the poynt, N, E.

In this Question you have the poynt of the Compasse given, as likewise, the Moones age, and to answer the question, you are to give the houre, wherefore bring the Index of the Moone unto her poynt N, E. then holding it still, turne the Index of the Sunne, untill you have brought the 15th, day of her age, right under the Index of the Moone, and then the Index of the Sunne, will poynt right in the Circle of 24. houres to 3. of the Clocke in the afternoone, which answereth the Question.

Note alwayes, that if your Question be resolved, and that the Index which answereth the Question, poynt to the Eastward

ward of either N. or S. it sheweth the morning 12. houres, but if to the Westward of the N. or S. it sheweth the evening 12. houres.

Thus much I thinke will be sufficient to give any one of a reasonable understanding the full use of this Instrument, which by often practising these and such like Questions, they will in short time be so ready in mind, that at the first propounding, you will be able to resolve them by memory, without any farther trouble, which will be a most excellent and profitable matter for the Practitioner of Navigation.

*How to find the time of Ebbing and Flowing
by this Instrument.*

YOU are first alwayes to consider what Poynt of the Compasse the Moone is upon that day that it changeth, when it is full Sea in that River, Port, or Creeke which you are to find the Flood or Ebbe, which having found, you must consider, what houre belongeth to that Poynt of the Compasse, which by turning the Index of the Moone as before is shewed; you shall have the houre alwayes right under her Index, upon the day of her Change throughout all the Poynts of the Compasse, and now you must proceed, to find full Sea in this manner; first turne the Index of the Moone, to the Poynt of the Compasse that upon her Change day maketh full Sea, in that Port, River, or Creeke, which you desire to know, and there holding it still, consider how old the Moone is, then turne the Index of the Sunne, untill you have brought the day of the Moones age right under her Index, and then the Index of the Sunne will answer the Question, and poynt right with the houre, as by these Examples will appeare.

First

First Question.

THe Moone 30. dayes old, at what a Clocke will it be full Sea at *London-bridge*.

Here you are to consider the Poynt of the Compasse that the Moone is upon when it is at full Sea upon her Change day, which in this Port is found by observation to be alwayes, S, W or N, E. (the opposit Poynt,) therefore observe, whether you would know the houre of the Day, or the houre of the Night, that is full Sea, if it be the houre of the Day, then bring the Index of the Moone to the S, W. Poynt, if of the Night, to the N, E. and there holding it still, turne the Index of the Sunne, untill you bring the 30. day of the Moones age right under her Index, and then the Index of the Sunne, will shew you in the Circle of 24. houres, 7. of the clocke in the Morning, or 7. of the clocke at Night, if you set the Index of the Moone to the Poynt N, E. then the Index of the Sunne will shew 7. of the clocke in the afternoone, at which houre it is there full Sea when the Moone is 30. dayes old, which answereth the Question demanded.

Note alwayes, that the Moone betwixt change and full, is ever to the Eastward of the Sunne, still seperating her selfe from the Sunne, untill she be at the full, but after the full, in regard she hath now performed more degrees in her separation then is contained in a Semicircle, she is gotten to the Westward off the Sunne, and now applyeth towards the Sunne againe, untill her change Day, which if you observe the Instrument, it doth plainly demonstrate.

Second Question.

THe Moone being 18. dayes old, I demand at what houre it will be full Sea at *Weymouth*.

In this Question, first consider what Moone maketh full Sea in that Port, which by experience is found to be East and
E West,

West; now therefore because the Moone is to the Westward of the Sunne, and is before the Sunne, being now 16. dayes old, you must bring the Index of the Moone to the poynt W. and there holding it, untill you have turned the Index of the Sunne, and brought the 16. day of the Moones age right under her Index, and then the Index of the Sunne will shew, that it will be three quarters past 6. in the Morning, when it is full Sea at that Port, the Moone being 16. dayes old.

Third Question.

THe Moone being 16. dayes old, I demand at what a Clock it will be full Sea at *Dover* in the Peere.

In this question, you must consider what Moone maketh full Sea upon the change Day, which is found to be N. and S. therefore I bring the Index of the Moone to the poynt N. and there hold it untill I have brought the 16th, day of the Moones age right under her Index, and then the Index of the Sunne will shew three quarters past 12. a clocke, which answereth the Question.

Fourth Question.

THe Moone 10. dayes old, at what a clocke is it full Sea at the Iland of *Garnesey*.

Here at this Iland, a N. by E. Moone upon the change Day, maketh full Sea; therefore turne the Index of the Moone to the poynt N. by E. then turne the Index of the Sunne, untill you have brought the 10th, day under the Moones Index, and then the Index of the Sunne, will shew that at three quarters past eight of the Clocke in the morning it wilbe full Sea, which answereth the Question.

Fifth

Fift Question.

THe Moone 26. dayes old, at what a clocke will it be full Sea under *Bulleine in France.*

In this place, a N, E. by N. Moone upon the change day maketh full Sea, therefore bring the Moone to the poynt N, E. by N. and then turne the Sunnes Index untill 26. be right under the Moones Index, and then the Index of the Sunne will shew, that at 3. minutes past 11. of the clocke, it will be full Sea.

Sixt Question.

THe Moone 29. dayes old at *Amsterdam,* what houre maketh full Sea.

In this place, a S, W. and N, E. Moone upon the change day maketh full Sea, therefore bring the Moones Index to the poynt S, W. or N E. and then bring the 29. day under her Index, and the Sunnes Index will shew, that it is full Sea at a quarter past 2. of the clock, which answereth the Question.

Thus I conclude, for finding the Flowing and Ebbing in all parts, by the ayd of this Instrument, and now I will in briefe shew how to find the Moones age by Arithmeticke, and how to account your Tides, as likewise, to find the Prime Number, and the Epact, which are the principall matters to find the Moones age (and in short) the Motion of the Moone.

How to find the Prime Number and what it proceedeth from.

THe Prime Number is the space of 19 yeares, in which time the Moone performeth all her Motions with the Sunne, at the expiration of which terme she beginneth againe, in the same signe of the Zodiacke, that she was 19. yeares before, and alwayes finisheth her whole course with

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the Sunne, in that terme, which she never exceedeth, so that if I have a desire to know any thing concerning the Moones age, or her motions in the Heavens, that she hath made many yeares past or (to come) onely by the helpe of Addition and Subtraction you may be resolved with as much certaintie, as if it were any thing in present: but to proceed for the finding of this Number so usefull, you must alwayes take this course. In that yeare of our Lord, which you would know what is the Prime Number, (adde one to) and then divide it by 19. and that which remaineth upon the division, and commeth not into the quotient, is the Number required; as for Example, in the yeare of our Lord 1631. I demand, what is the Prime Number, now therefore if you adde one, to the aforelaid yeare, and divide the of-come by 19. there will remaine upon the division, that commeth not into the quotient 17. which I say is the Prime Number, and for this matter being so easie, I neede not use more demonstrations, onely you are to observe, when you find nothing remaining upon the division, that is the last yeare of the Moones Revolution; and therefore may conclude, that 19. is the Prime for that yeare, and you must also note, that the Prime alwayes beginneth in *January*.

How to find the Epact, and what it proceedeth from.

THE Epact is a Number that proceedeth from the difference which is made in the space of one whole yeare, in accompting the Moones rearmes, and the Sunnes. for the *Solar* yeare doth containe neereſt 365. dayes, 8. houres, 48. min. and the *Lunar* yeare doth containe after the rate of allowing her 30. dayes betwixt Change and Change, 360. dayes but 11. houres and 16. minutes, which in the tearme of each 30. dayes must be frustrated, because 30. dayes, is so much more then in truth is contained, which in the terme of 12. Moneths, amounteth to 5. dayes, 15. hou. and 12. min. and the *Lunar* yeare wanteth of the *Solar*, 5. dayes, 8. hou. and 48. min. neereſt

nearest, both which summes being added together, will make 11. dayes, and now to proceed, to find the Epact, do in this wise multiply the Prime Number for the yeare, by the differences of the Solar and Lunar yeares, which I have shewed to be 11. dayes, and then divide the product by 30. dayes, and that which remaineth upon the division, & cometh not into the quotient is the Epact; as for Example, in the former yeare, 1631. where I shewed you to find the Prime Number, which appeared to be 17. Now therefore if you multiply 17. by 11. it will make 187. which being divided by 30. there will remaine upon the division, that cometh not into the quotient 7. which is the Epact for that yeare, and this is sufficient to be expressed in so facill a matter; onely you are ever to note, that the Epact beginneth in *March*; by these examples, I make no question but you understand the reason of the Prime, and Epact, as likewise how to find them in any yeare that you desire; but in regard, those which are unacquainted with Arithmeticke, are debarred from the way of these two most necessary Numbers, I will make a small table for 40. yeares yet to come, wherein any one shall most facilly find the Prime and Epact, for any yeare that he shall desire, but in the first place, I will shew the use and operation of these two Numbers, in finding the Moones-age and the shifting of Tides.

How to find the Moones-Age, at any time.

HAVING attained to the finding of the Prime and Epact you may find the Moones age at any time desired, in this manner; first consider the Moneth, and day of the Moneth that you desire to finde her age, and then reckon how many Moneths are contained betwixt your present moneth, and the moneth of March, including both those moneths, in your Number, then adde the Epact for that yeare, and all those summes being added together, is the Moones age, if it exceed

not 30. which if it doth, you must cast away 30. so often as you can, and then the remaining is her age; as for Example, in this present yeere of our Lord 1634. the Prime Number is 3. and the Epact is 11. now I demand, what age the Moone is of, the 24th day of Iuly, from March to Iuly, is 5. months, (including both Moneths) which being added to 24. the day of the Moneth maketh 29. and then adjoyne the Epact, it will make 40. therefore casting away 30. there will remaine 10. which is the age of the Moone, and answereth the Question.

How to find when it is Full-Sea in any Port, Creeks, or River.

HAVING shewed formerly how to find the Prime, Epact, and age of the Moone, at any time desired, you may proceed for the finding of full Sea in any place in this manner; first you must consider, as afore is shewed, what poynt of the Compasse the Moone is upon on her change day, when it is full Sea in that Port which you desire to know, and likewise what houre is proper for that poynt, which having considered, as likewise, how old the Moone is, you may by Arithmetick instantly resolve, the Moones age being multiplied by 4. and the ofcome divided by 5. adde the houre proper, to the poynt of the Compasse the Moone is upon, in her time of Change, if there remaine any thing upon the division that cometh not into the Quotient, for every one that remaineth you must adde 12. minutes, for 2. 24. minutes, for 3. 36. minutes, for 4. 48. Minutes, and more then foure you shall never have upon your division; by a few Examples, the manner of worke will appeare most easie and plaine, which of purpose, I will now take those 6. Questions, which formerly I did resolve by the Instrument, that the worke may appeare more plaine and certaine, to those which are acquainted, and can worke by them both, and the truth of the Instrument will be more plaine, by comparing both together, as for Example.

First

The Navigator.

29

First Question.

THe Moone 20. Dayes old, at what a Clocke is it full Sea at London-bridge.

Here you must consider the point of the Compasse that maketh full Sea upon the change day, which is found to be S, W. and N, E. and the houre proper, to that poynt is 3. therefore I proceed and multiply 20. the Moones age, by 4. and it maketh 80. which I divide by 5. and there commeth 16. into the quotient, which is houres, and nothing remaineth upon the division; therefore, I onely adde 3. to 16. and it maketh 19. which because it exceedeth 12. I cast away 12. as often as I can, and there remaineth 7. which is the time of full Sea, and answereth the houre demanded; you must ever note, that if the generall summe exceed 12. you must take 12 so often as you can out of it, and the remainder will answer the Question most certainly.

Second Question.

THe Moone is 16. dayes old, at what a Clock will it be full Sea at Weymouth.

Here at this Port upon change day, an E. and W. maketh full Sea, therefore you must multiply 16. the Moones age by 4. and it will make 64. which being divided by 5. there commeth into the quotient 12. houres, and there remaineth upon the division 4. which as hath beene formerly shewed, signifieth 48. minutes; therefore adjoyning those 48. minutes unto 12. houres, it appeareth most plaine that at the aforesaid Port, it will be full Sea at 48. minutes past 12 of the clocke, which answereth the question.

Third Question.

THe Moone being 10. dayes old, at what a clocke is it full Sea at the Island of Garnesey.

Heere

Here at this Port upon Change day, a N. by E. Moone maketh full Sea, therefore I multiply 10. dayes being the Moones age, by 4. and it maketh 40. which summe I divide by 5. and there cometh into the Quotient 8. houres, and nothing remaineth upon the division, therefore you must onely adjoyne the houre proper to the poynt, and the question is answered, which upon this poynt of N. by E. is 12. houres, 48. minutes; therefore I omit the 12. houres, and onely adde the 48. minutes, so that it appeareth at 8. of the Clocke, and 48. minutes past, it will be full Sea, in the aforesaid Port.

Fourth Question.

THe Moone 16. dayes old, at what a Clock is it full Sea at *Dover* in the *Peere*.

In this place, a N. and S. Moone; therefore worke as afore hath beene shewed, and you will find, at 48. minutes past 12 a Clocke.

Fifth Question.

THe Moone 26. dayes old, at what a clock is it full Sea at *Calloigne* in *France*.

Answer, a N. E. by N. Moone, therefore at 11. a clocke and 30. minutes past.

Sixth Question.

THe Moone 29. dayes old, at what a Clocke is it full Sea at *Amsterdam*. Here a S. W. and N. E. Moone, therefore at 3. houres and 12. minutes.

Hereafter followeth the Table for the Prime and Epact, Calculated for 40. yeares yet to come from this present yeare 1634. the table is so plaine, it cannot chuse but be understood by any at the first sight.

of

Of the Moones Motion, and the proportion of Time
betwixt Tide and Tide.

HAVING formerly shewed the severall wayes how to find the Moones age, first by the helpe of Instrument, and then Arithmetically, by getting the Prime Number, and Epact, for the yeare of our Lord; having which, you are able to find the time of full Sea in any Port you desire; I will now shew you in brieft, the Motions of the Moone, and the reason of the difference of time betwixt Tyde and Tyde: the Motions of the Moone are two-fold, first, a violent motion, which is from E. to W. caused through the Diurnall swiftnesse of (*Primum mobile*;) secondly, a naturall motion, from W. to E. in which motion the Moone doth require 27. dayes, and 8. houres, to come to the same minute of the Zodiacke, from whence she departed, but comming to the same Pricke where she was in Conjunction with the Sunne last, she doth not find him there againe, in regard the Sunnes naturall motion is every day one degree or 60. minutes E. which maketh so much difference, that the Moone must performe 2. dayes, 4. houres, and 36. minutes neerer, more then her naturall motion, before shee can fetch up the Sunne to come into conjunction with her, so that betwixt Change and Change, is 29. dayes 12. houres and 36. minutes, by my account, but the Sea-man, doth allow just 30. dayes, betwixt Change and Change, in regard he will not be troubled with small fractions of time, in his account of Tydes, which bringeth no greater error; therefore Experience being my best authority in this poynt, I will likewise give the same proportion, allowing the Moone in every 24. houres, to depart from the Sunne 12. degrees, or 48. minutes of time, which is untill her full E. but then having performed in her naturall motion, above the quantity of a Semicircle, she is then to the West, as reason expresseth. Now if the Moone move in 24. houres 48. min. then in 12. houres, she must move 24. minutes, and in 6. F
houres,

houres, 12. minutes, by this proportion, each houre she moveth 2. minutes, and as the difference of time is, so is the difference of Tydes.

A Table shewing the Prime and Epact for 40. yeares yet to come.

The y. of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.	Yeare of our Lord.	Prime.	Epact.
1634	1	11	1644	11	1	1654	21	11	1664	31	11
1635	2	12	1645	12	12	1655	22	12	1665	32	12
1636	3	13	1646	13	13	1656	23	13	1666	33	13
1637	4	14	1647	14	14	1657	24	14	1667	34	14
1638	5	15	1648	15	15	1658	25	15	1668	35	15
1639	6	16	1649	16	16	1659	26	16	1669	36	16
1640	7	17	1650	17	17	1660	27	17	1670	37	17
1641	8	18	1651	18	18	1661	28	18	1671	38	18
1642	9	19	1652	19	19	1662	29	19	1672	39	19
1643	10	20	1653	20	20	1663	30	20	1673	40	20

Of the Globe.

After that the young Practitioner of Navigation hath attained to perfect knowledge of all the poynts of his Compasse, and that he is well acquainted with the shifting of all manner of Tydes, the next principall, resteth most properly upon the terrestiall Globe, where all manner of distances, are to be measured, which cannot be attained unto, without the knowledge of the nature and quality of many severall Circles which girt the whole body, therefore I will briefly define them, and shew reasons in the matters of most Importance.

of

Of the ball of the Globe.

First, the Ball or round body in his upper superficies, doth onely demonstrate unto us the Hidrographicall description of the Sea, and the Geographicall description of the Land; this Superficial knowledge, the weakest Capacity discerneth at the first sight, for by the description of the Seas and Lands, it appeareth which is Sea, and which is Land, and then that both of them joyntly together make one round body is most evident.

But this knowledge proceeding not from reason, and the rules of Art, is as farre from perfection as the (*Chaos*) was before it pleased the divine Creator, to separate the confused mixture of the Elements into their proper places; for now you behold a body of an exact round forme, but are not able to measure any part of him, neither know how it is Scituated, in respect of the Sphaeres which turne round about him; now then it is most necessarie for us to set this round body in his proper place, and then to divide him with Circles according to Art, whereby we may gaine the knowledge of each severall places, distance from each other, as likewise how they are Scituated, in respect of the motions of the Sunne and Starres.

First, then I place the whole Globe, according to my conceived apprehension to be even Scituated in the very center, and that this whole body in respect of the Heavens hath in all respects, the same resemblance that a small poynt or prick being the center of a large circle (hath to his circumference;) the Globe being thus placed, it is most facill to conceive that a perpendicular line falling from the Heavens, and running through the Globe or Center, to the opposite part of the Heavens, can be but in two certaine poynts, which two poynts we terme or call the Poles of the World, expressed by the denominations, of Articke and Antarticke, and the Perpendicular, we call by the name of the Axeltree; be-

cause upon the period of their extreames, wee suppose the Spheares are turnd about by the force of (*Primum mobile*) or the first mover, the terrestiall Globe being thus Scituated in your imagination, with this Axeltree running directly through him, may now be girt with his severall circles, where by evident and infalliable conclusions, wee are able by plaine demonstrations to give all manner of distances, as likewise the content of the whole Body.

Of the Equinoctiall.

THe first Circle, as the foundation for all the rest which I will describe upon the terrestiall Globe is the Equinoctiall, wch must be extended from E. to W. leaving both the afore mentioned Poles of one equall distance, from all parts of the whole circle, this Equinoctiall Circle is divided into 360. deg. and importeth by his denomination his nature and quality, by two distinct operations: First, in dividing the whole World into two equall parts, allowing the one halfe of the Terrestiall Globe, to appertaine unto the North or Articke Pole, and the other to the South or Antarticke Pole; Secondly, alwayes when the Sun by his yearly motion Intersecteth the Equinoctiall poynts, the dayes and nights are of one equall length in all parts of the World, and so the denomination of the word, is probable to come from the Latin (*Equales dies & noctis*), and now the Globe being onely circled with the Equinoctiall, the foundation of measuring is laid, but small use can be drawne from this foundation, untill we raise some other buildings which will shew his use by the effects.

Of the Meridian.

THe Terrestiall Globe having as yet but one onely Circle, namely the Equinoctiall, which divideth the world into two equall parts, I find it most Convenient to describe another circle of the same magnitude, though of a severall nature

ture, namely the Meridian, this Circle runneth directly North and South, even through the imagined Poynts which wee terme the Poles; and intersecteth the Equinoctiall, at right Angles: so the Globe is Quartered into foure equall parts, which the meanest capacity cannot chuse but conceive, now by the ayde of these two Circles, we are able to measure all parts or portions of all other Circles, that are extended betwixt any two places upon the Terrestiall Globe; as likewise to give the whole content of the circumference, in any kind of measure that shall be required: The certaine truth of our measuring, is grounded upon taking the Altitude or height of some knowne body Scituated in the Heavens, for by such an observation, wee conclude an infallible certainty, as by a short demonstration shall appeare.

As for Example, suppose I am here in *London*, a place well knowne by divers heedfull observations, to be Scituated in the Latitude or bredth from the Equinoctiall 51. deg. 32. min. Imagine, that I take any certaine number of any sort of measure, directing my course dew South, untill I find by the Starres or Sunne, that I have altered my Latitude or bredth one degree, which by experimentall conclusions is found, must needs bee sixty English Myles, or twentie English Leagues, before I can have any such alteration: Now then I conclude, if I must goe 60. English Myles or 20. Leagues, due South; before the North Starre will be one degree lower then it was; That if I were under the Pole, where I should have the North Starre in my Zenith, I must needs goe or Saile 90. degrees, before I come to bring the Equinoctiall in my Zenith, and the Starre in my Horizon: for betwixt the Pole and Equinoctiall is a Quadrant, or fourth part of a Circle, as before I have shewed. Now then by the rule of proportion, (or reason) if one degree of the Meridian, require 20. Leagues, or 60. Myles, 90. of the same degrees, will require 1800. Leagues, or 5400. Myles, which is one quarter of the Globes circumference, and then it is most apparent, that the whole terrestiall Globe is but foure times as much, which

is 7200. English Leagues, or 21600. Myles, and so much is the whole circumference in the Equinoctiall or Meridian, and now againe, if one degree containe 20. Leagues, or 60. Myles, then 7200. Leagues, or 21600. Myles, will containe in the same proportion 360. degrees, which is likewise the whole circumference of the Terrestiall Globe in degrees, and the fourth part of those degrees must needs be 90. degrees, so that by this demonstration, it appeareth there can be no doubt of the certainty of our measuring. Now then, these two Circles of one magnitude, namely the Equinoctiall and Meridian, being exactly divided into 360. equall parts or degrees, as you shall ever find them upon the Terrestiall Globe, maketh all kind of distances betwixt any places assigned, most facill to be measured, for if you take the distance of any two places with your Quadrant, which is onely a thin plate of brasse, containing the exact fourth part of, of degrees, either of the Equinoctiall or Meridian, you will see what quantity of degrees are contained betwixt them, which may soon be turned either into Leagues or Myles, by allowing for each degree 20. Leagues or 60. Myles as hath beene manifested before, these two Circles thus divided and described, and with certaine and infallible truth proved by the former demonstration, is sufficient to satisfie any man for the measuring of all sorts of distances, upon the Terrestiall Globe, and the way of measuring is so plaine, that it is not common sence should find any difficulty; but yet you must understand, that although I have mentioned but one Meridian upon the Terrestiall Globe, yet you shall finde divers Meridians described upon all Globes, yet but one that is graduated or divided into degrees, which serveth as well as if they were all divided, for they are of one nature and quality, and intersect each other in the very poynts which wee call the Poles, and all of them cut the Equinoctiall at right Angles.

The Meridian thus described discovereth most evidently the fallenesse of the Cards or Plats, which are projected in
Plano

plano : for there you shall find divers Meridians likewise described, (namely all North and South lines) with one graduated Meridian as in the Globe, but you will finde them all Parallels to each other in all Latitudes or bredths, even to the very Poles, where according to the Globe they should intersect each other, so that when the foundation is false, you may well consider, what dangerous errors those runne into, which allow the Card or Platt, because most easie, most excellent for Navigation.

I have sufficiently defined these two Circles, by the aid of which, as hath beene expressed, all manner of distances may be resolved. Yet there remaineth divers Circles which must be understood, or you will understand the nature and quality of the Globe but in part.

Of the Ecliptick.

THe Ecliptick is a Circle of the same magnitude of the Meridian, and Intersecteth the Equinoctiall at two certaine poynts which divideth it into two equall parts, but not at right Angles, as the Meridian, but with Accute or Sharpe Angles, and so the greatest Archer of the Ecliptick, cannot be distant from the Equinoctiall, above twenty three degrees and thirty minutes, which 23. deg. 30. min. is likewise the quantity of the Angle, which is ingendred by their Intersections, the chiefe use of this Circle, is to demonstrate unto us the yearly motions of the Sunne, through the 12. Signes of the Zodiack; this Circle is divided into 360. degrees, shewing the daily motion of the Sunne, and these 360. degrees are distributed amongst the 12. Signes in a proportionable manner, namely to each Signe 30. degrees, so that according to the Sunnes dayly declination, we are able to shew the degree and minute of the Ecliptick, where she Intersecteth, which taketh his name according to the denomination of the Signe, by the knowledge of which, wee conclude the degree and minute of the
Sunnes

Sunnes declination or distance, from the Equinoctiall, which is the chiefe director in finding how any place is Scituated upon the Terrestiall Globe, in respect either of the Equinoctiall or Poles, for though in a vulgar phrase, it is commonly termed the Altitude or height of the place, where wee observe the Sunne or Starres, with our Geometricall Quadrant Astrolab, Crosse-staffes or such like Mathematicall Instruments; Yet I say the bare height of any body Scituated in the Heavens (which each one of the meanest Capacity, is able at the first demonstration to resolve) is of no consequence to discover the Latitude or breadth of that place, either from the Pole or Equinoctiall, except you are able at time of observation, to give the true declination of the body which you observe, and then indeed you may conclude an infallible certainty, namely how many degrees and minutes your place of being is both from the Equinoctiall and Poles.

Of the Colures.

THe Colures are onely two Meridians, which are, as it were bounds or markes, shewing what degree of the Eclipticke the Sunne intersecteth, when shee maketh her greatest North and South declination, as likewise, where and in what signe shee intersecteth the Equinoctiall, where shee hath no declination, these intersections of the Colures, plainly demonstrateth unto us, the division of the foure quarters of each Year, and when they begin and succeed each other, as namely the Colure which intersecteth the Equinoctiall and Ecliptick, (where they likewise intersect each other) is called the Equinoctiall Colure, and sheweth that the Sunne hath no declination, from which intersection, wee have the denomination of two of the foure Yearly quarters, for if the Sunne be in the last minute of *Pisces*, or entring into the first minute of *Aries*, it sheweth the first of our Spring, and that the Sunne hath passed that Equinoctiall Poynt, and is making her North declination, whose glorious presence as much reviveth both Man, Beasts,

Beasts, and Plants, Scituated towards the Artick Pole, as her absence maketh them droope towards the Antartick, and this interfection is ever neere the 10th, day of *March*, but if the Sunne be in the first minute of *Libra*, or the last of *Virgo*, when shee interfecteth the Equinoctiall, our Artick Pole mourneth for the Sunnes ensuing absence, and the Antartick rejoyceth for her approaching presence; this Equinoctiall poynt, sheweth the beginning of our Winter, and their Summer, which are Scituated to the South or Antartick, which ever happeneth neere the 11th, day of *September*.

The other Colure, is called the Solsticiall Colure; because the Sunne having now his greatest declination, is not to be discerned for two or three dayes, to have any sensible alteration: This Colure interfecteth the Ecliptick in his greatest Arches, on either side of the Equinoctiall, by which interfections, the two other quarters of our Yeare are expressed, as namely, if the Sunne be in the last Minute of *Gemini*, or entering into the first minute of *Cancer*, it sheweth that the Sunne hath now her greatest North declination, and that now when she interfecteth her Meridian at Noone, shee hath the greatest Altitude above the Horizon, to all places Scituated towards our Artick Pole that is possible for her to have, which is the cause that now wee have our longest Dayes and shortest Nights, and now beginneth our Autumne or Harvest, and this interfection happeneth ever neere the 10th, day of *June*, but if the Sunne be in the last minute of *Sagittaries*, or entering into the first minute of *Capricorne*, it sheweth the Sunne hath now her greatest South declination, and is of the least Altitude above the Horizon, when she interfecteth the Meridian at Noone, to all that are Scituated towards our Artick Pole, that she ever possible may be; which causeth our shortest Day and longest Night, that is the dead of our Winter, and the beginning of Autumne or Harvest, to all those which are Scituated towards the South or Antartick Pole, this interfection ever happeneth neere the 11th, day of *December*.

of

Of the Rombe.

THe Rombes or Courses, are all Circles of the greatest Magnitude, onely when the Equinoctiall is in your Zenith, but if otherwise, then I say they are Circles, bearing proportion with the Paralell where you are, as this plaine and easie demonstration will manifest.

Suppose that according to heedfull observation, our place of being were right under the Equinoctiall Line, and that then we should take any notice onely of the 2. poyns of our Compass, according to each severall Rombe of E. and W. and then doe out consider that our place of being is in the very intersection of the Geographical Equinoctiall, which is described upon all Terrestrial Globes, reason resolveth the matter, for as that Circle of the greatest magnitude, is produced through the extreame extension of E. and W. so the Rombe of E. and W. shewed by the Compass, must needs according to his greatest extension, be of the same magnitude, and then likewise, if you observe your N. and S. Rombe, you will with the like facility perceive, that it intersecteth the Equinoctiall, or your E. and W. Rombe at right Angles; and therefore in that place, must be a Circle according to his greatest extreame of the same magnitude with the Meridian. And then it followeth most plaine, that all the other Rombes running through the aforesaid Intersection, must now bee Circles of the greatest magnitude in theyr extreame extensions.

But if you observe the Rombes by your Compass in any Paralell or Latitude, there will appeare but one Rombe or course that will be a Circle of the greatest magnitude, namely your N. and S. course, which is alwayes your true Meridian (if the Compass have no variation,) and therefore according to his extreame extension is a Circle of the greatest magnitude; but now your E. and W. Rombe will not hold proportion with the Meridian, because all Paralels are lesse then the Equi-

Equinoctiall, and therefore now all the rest of your courses or Rombs besides your N. and S. course, are Circles according to their greatest extreames of a lesser magnitude; as for Example, suppose we are in the Latitude or Paralell of 60. degrees from the Equinoctiall, and now observe the E. and W. and N. and S. Rombes by our Compasse, we shall find they intersect each other at right Angles, but wee must not conclude as before, that according to their extreame extensions, they are both Circles of the greatest magnitude; for here in this place, the Globe plainly demonstrateth unto us, that the E. and W. Rombe or Paralell in his greatest extreame, is but halfe so bigg as the Equinoctiall; therefore all the rest of the Rombes or courses, except the N. and S. Rombe, must hold the same proportion. I would have the Practitioner of Navigation to discusse most diligently upon the aforesaid demonstrations, which are most easie, and will prove most excellent for producing the reall truth of many matters in Navigation, as by divers future conclusions will bee manifested.

Of the Tropicks.

THese two Circles are of one magnitude, and are Paralels to the Equinoctiall intersecting the Solstitiall Colure, at the Latitude or bredth of 23. deg. 30. min. and these two Circles represent the utmost bounds of the Sunnes declination, on either side the Line; and are touch lines to the great Arches of the Eclipticke in two certaine Signes, from whence they take their severall denominations, namely our Northerne Tropicke toucheth the Eclipticke in the first minute of *Cancer*, and therefore is called the Tropicke of *Cancer*, and the Southerne Tropicke, toucheth the Eclipticke in the first minute of *Capricorne*, and is likewise called the Tropicke of *Capricorne*, betweene these two Tropicks, and under the Equinoctiall, round about the whole circumference of the terrestiall Globe from East to West, is scituated that Zone which formerly hath beene termed (*Torrida Zona*)

or the burning Zone, for in any place betwixt the two Tropicks, or within 23. deg. 30. min. of the Equinoctiall, you shall have the Sunne twice each yeare in your Zenith or Perpendicular, right over your head, at which time it hath beene the opinion of many great Philosophers, that the powerfull influence of the Sunnes bright beames being extended right downewards, the heate occasioned by their reverberation was insufferable, which indeed according to humane reason doth appeare very probable, and I am still of their opinions though I have beene divers times for many Moneths together, Sayling within the Torrid Zone, in most temperate weather, when the Sunne hath bene according to our Course constantly right over our heads, or very neere our Zenith Poynt.

But this temperatenesse is occasioned by a Supernaturall operation, which the Divine Creator in his great Providence hath provided as a remedy to qualifie the parching heate of the Sunne beames, namely a certaine breez or gale of wind, which ever bloweth betwixt the N. and E. in those parts. And it is worthy of observation to behold the great goodnesse of our Maker, that hath appoynted this remedy daily to rise with the Sunne, whose powerfull beames would so much annoy the inhabitants, and ever as the Sunne riseth above the Horizon by degrees, untill she come to her Meridian or greatest Altitude, so the breez of wind commeth by degrees ever increasing and blowing more freshly as the Sunne riseth, so that when the Sunne is at highest, the breez ever bloweth most freshly, and so decreaseth againe as the Sunne groweth lower, untill she be set under the Horizon, and then the breez is likewise done. And now yeeldeth as much benefit to Mortall man by ceasing to blow in the Night as it did profit him in qualifying the heate of the Day: For if it should blow as freshly in the Night time, as it doth in the heate of the Day, when the powerfull beames of the Sunne is qualified, it appeareth in common reason, that if the Sunne were wholly absent, and that the coole wind should still

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continue, the Inhabitants would be very sensible of such a suddaine alteration, and feele it most extreame colde, and so would breed a great distemperature in theyr bodyes; but the generallcalmes in the Night, when the Sunne is wholly absent answereth a proportionable temper. And so we must onely praise our Maker for his benefits, and not strive to render reason for Supernaturall matters, onely we may presume in way of comparison, that as it hath pleased the Great GOD to provide remedy beyond our reason, for the Parching heate, that hee hath likewise provided some supernaturall meanes, for (*Frigida Zona*) or the Frozen Zone; that it may be Inhabited (as I make no question but it is,) although in our reason, the influence of the Sunnes beames, are of so small power in the Regions Scituated neere unto either of the Poles, that they can yeeld little comfort, either to Man, Beast, or Plants; and againe, the Sunne ever being absent and never seene above their Horizon, at either of the Poles, for 6. Moneths together, when the Equinoctiall is betwixt them, and the distance where she maketh her motion, which exceedeth above a Quadrat or quarter of the Meridian, and therefore not to be discerned. Yet I say for all this, it may be Inhabitable, as no question but future times will discover both it and greater matters, that as yet remaine lapt in obscure clouds neere unto the Poles.

Of the Paralels.

VPon the Terrestiall Globe there may bee described infinite Circles from East to West, betwixt the Equinoctiall and Poles which will be Paralels to each other, but no Circles described from North to South can bee Paralels: because theyr Meridians, Intersect each other in the points, termed the Poles; these Paralell Circles described from East to West, have all of them one Center from whence they are described, namely the Poles, and from that Center there can bee but one Circle described of the same magnitude with the

Meridian, which is the Equinoctiall, all other Circular Paralels are of lesse magnitude, ever decreasing as they are described neerer to eyther of the Poles, so that at the Latitude of 60. Degrees, that circular Paralell is but halfe so bigge as the Equinoctiall, and circular Paralels scituated neerer; the Poles are still of lesse Magnitude untill you come to the very Center or Pole, where it is not capable of any thing being onely a point.

The want of due consideration, what proportion each severall Paralell, in each severall Latitude beareth in respect eyther of the Equinoctiall or Meridian, is the cause the Navigators of these dayes produce such lame and imperfect Conclusions, as many times by Experience I have found, that in running 8. or 9. hundred Leagues, and raising the Pole not above 12. Degrees, the chiefe men in generall which were in our Ship have beene short in the true Longitude, when wee were in the height or Latitude of the Place neere upon 200. Leagues, which Error I plainly Demonstrated, proceeded onely for want of knowledge of the proportions of each severall Paralell; but because those proportions were beyond theyr capacities to finde out, they would have all Concluded, wee had made more way with the Ship then was accounted of, and so would have clocked a most grosse Error with a generall mistake, but my reckoning being different from them all and pointing with the truth, I would not allow of theyr Conclusions, but by playne Demonstration most easie for any of them to conceive, I shewed the falsenesse of all Cards in *plano*. (which have all equal Degrees in the Meridian) and what lame Conclusions must bee expected from those which in long Voyages put theyr trust in them; the Demonstration which I produced was taken out of that worthy Author, Mr. *Edward Wright*, who hath excellently Corrected and detected the Errors of Navigation.

Suppose two Ships sayling right under the Equinoctiall Line, and it were certainly knowne, that they were East and West from each other the exact quantity of 100. Leagues, I demand

demand if those two Ships should now saile both of them due North untill the Pole were Elevated 60. degrees, how many Leagues would these two Ships bee from each other.

According to your Cards in *Plano*, which maketh all Meridians to be Parallels, and all Parallels of the same Magnitude with the Equinoctiall, apply your Compasses, and you will find even 100. Leagues, the same distance as at the Equinoctiall, then which there is nothing more contrary to truth; For all Meridians according to the Spherical body of the Globe must intersect each other at the Poles. Now then two Meridians intersecting the Equinoctiall at right Angles, and distant from each other at those two Intersections 100. Leagues must needs at the Latitude of 60. degrees where the Circular Paralell is but halfe the Magnitude of the Equinoctiall, not exceed halfe the distance they had at the Equinoctiall, and so to conclude with truth, those two Ships are now but 50. Leagues distant from each other. The due proportion that all Parallels have to the Equinoctiall and Meridian in all Latitudes is too curious a worke, for many men to performe; yet for the love which I beare in generall to all the Practizers of this Art, I have with the expence of a great deale of paines already calculated two small Tables which will appeare in the ensuing worke, whereby the meanest Mariner shall bee able at first sight to resolve the proportion of all Parallels, in respect of the Equinoctiall and Meridian; as likewise the differences of their Longitudes both in Leagues, Miles, and Paces, thus much of the Terrestrial Globe, with all manner of Circles described upon him, which if they be judiciously observed, is as much as is possible to be demonstrated, and will sufficiently satisfie any reasonable capacity for the full understanding of the whole Terrestrial Globe in all his particular Circles of severall natures and qualities.

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Of Latitude.

Latitude importeth as much as breadth, being alwayes that Portion of the Meridian which is contained betwixt two Paralels, the Equinoctiall being ever one, and your point of being the other; for if a Paralell were extended from the Poynt of your being untill it made a whole Circle, and joyned againe in your first poynt, you might runne all the degrees of that Circles Longitude untill you arrive againe at the first poynt: And never alter one minute of your first Latitude.

Of finding the Latitude.

After the Practitioner of Navigation, hath thoroughly understood all the Principals, which are afore-mentioned, I hold it convenient that he should now use his endeavour to take the Altitude of bodyes scituated in the Heavens, as (Sunne and Starres) by which Altitudes, he shall most facilly find the Latitude or breadth which he is in, for the handling of your Geometricall Quadrant, Astrolab, Crosse-staffe, or such like Instruments, in time of observation it so facill, that at the first sight Common sence cannot but conceive it; therefore I will of purpose omit that matter, and proceed to the manner of worke after the Altitude is gained. Now then to attaine this Latitude or portion of the Meridian contained betwixt your Paralell and the Equinoctiall, you must be very circumspect in observing these three things: First, the Altitude of the Sunne according to the side of the Angle given by your Geometricall Instrument: Secondly, that you know the declination of the Sunne for that day, when she intersecteth the Meridian: Thirdly, that you have a speciall care to consider the scituation of your Zenith Poynt, in regard of the body observed (of which Poynt) it must alwayes (if you have Latitude) be found in one of these three respects; first, either the

the Sunne is betwixt your Zenith and the Equinoctiall, or else the Equinoctiall is betwixt the Sun and your Zenith, or Thirdly your Zenith is betwixt the Sunne and the Equinoctiall. Now these three different situations of your Zeniths maketh three severall sorts of working to find the Latitude, after you have observed the Altitude, which by Examples of each severall situation I will heere make plaine, with the manner of worke, very easie to be understood by the meanest Capacity, if he will but take some small paines to conceive the reason of the worke, produced by Zenith distance and declination rightly applied.

First Question.

I Demand, how I shall give the Latitude here at *London* the 11th, day of *June*, according to the Altitude of the Sun observed.

Here I consider by my Ephemerides, or by the common Tables calculated, that the Sunne hath to day 23. degrees, 30. minutes North declination, when she is due South or upon her Meridian.

Then I consider the situation of my Zenith poynt, and I find that the Sunne is betwixt it and the Equinoctiall.

Wherefore now I take my Geometricall Instrument, when I find the Sunne almost South, or upon her Meridian, and continue observing untill I have her at the greatest Altitude which here admit I find, is 61. deg. 58. minutes, which Altitude I Subtract from 90. deg. 00. min. and have remaining 28. deg. 02. min. therefore I conclude, that is the distance of the Sunne to day from my Zenith Poynt. And in regard I find the Sunne hath to day North declination, and that my Zenith poynt is situated, containing the Sunne betwixt it and the Equinoctiall. I joyne my declination and my Zenith distance from the Sunne into one summe, which I say is the true Latitude or Breadth of *London* from the Equinoctiall.

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The Navigator.

Manner of Worke.

	deg. min.
The quantity of your Quadrant, is alwayes	90 — 00
The Altitude found by observation to day, is	61 — 58
W ^{ch} Alt. subtracted & remainer is & Zenith distance,	28 — 02
Declination of the Sunne to day, is	23 — 30
W ^{ch} being joynd to & Zenith distance, the Lat. is	51 — 32

This Rule holdeth in all Latitudes of like scituation and serveth for ever in this Latitude and all others that are more Northerly then 23. deg. 30. min. provided the Sunne have North declination when you observe his Altitude.

Now you may very easily conceive by this question, that you have to day the greatest Altitude of the Sunne that you can possible have in this Latitude of 51. deg. 32. min. because the Sunne to day is in the Tropick of Cancer and hath made her greatest North declination which is 23. deg. 30. min. so the Sunne is but 28. deg. 2. min. distant from your Zenith Poynt, which if you subtract from 90. degrees, 00. minutes, the distance of your Zenith from the Horizon, the Sunnes Altitude appeareth to be 61. deg. 58. min. higher then which you shall never find her, here at London.

Second Question.

I Demand, how I shall give the Latitude here at London the 12th, day of December, according to the Altitude observed.

First, I consider the Sunnes declination for the day, and find it 23. deg. 30. min. to the Southward of the Equinoctiall.

Secondly, I consider the scituation of my Zenith Poynt, and find the Equinoctiall is betwixt the Sunne and my Zenith because the Sunne hath South declination and my place of being is to the Northward of the Line.

Wherefore now I take the Meridian Altitude with my Geometricall

metricall Instrument as afore, which admit I find to bee 14. deg. 58. min. which I Subtract from 90. deg. 00. min. the whole Quadrant, and thereresteth 75. deg. 2. min. which I say is the distance of the Sunne from my Zenith: And now because the Sunne hath 23. deg. 30. min. South declination, I subtract it from my Zenith distance, 75. deg. 2. min. and thereresteth 51. deg. 32. min. which I conclude is the Latitude desired.

Manner of Worke.

	deg.	min.
The whole quantity of your Quadrant, is alwaies	90	00
The Aititude found by observation, is	14	58
The Zenith distance, is	75	02
The declination of the Sunne, is	23	30
Which being Subtr. from the Zenith distance, Lat. is	51	32

By this question, it appeareth plaine that the Meridionall Altitude of the Sunne to day being 14. deg. 58. min. is the least that is possible for you to have in this Latitude, because the Sunne to day is in the Tropick of *Capricorne*, and hath made her greatest South declination, which is 23. degrees 30. minutes.

Take this briefe Rule for all places having your Zenith situated as afore, that if the Sunne have South declination, you subtract the declination from your Zenith distance, and the remainder is the Latitude: But if the Sunne have North declination, joyne the declination with your Zenith distance and the product is the Latitude desired.

Thus have you the way to find the Latitude according to the situation, of two of the three Zeniths, by observation of the Sunnes Meridionall Altitude. Now for the third, you may conceive it can never happen, but when your being is betwixt one of the Tropicks and the Equinoctiall, for except you are within 23. deg. 30. min. of the Line, it is impossible to have your Zenith betwixt the Sun and the Equinoctiall; but

finding your Zenith so situated, you must proceed to find the Latitude of the place by the Altitude observed, in this manner; subtract your Zenith distance from the declination of the Sunne that day, and the remainder is the Latitude or breadth from the Equinoctiall desired.

Third Question.

I Demand, how I shall give the Latitude of *St. Christophers* Island the 12th, day of *June*, according to the Altitude of the Sunne observed.

First, seeke the declination of the Sunne for that day, and you will find it 23. deg. 30. min. to the Northwards of the Line.

Then consider the situation of your Zenith Poynt, which will appeare to be betwixt the Sunne and the Equinoctiall. Now take your Geometrical Instrument, and observe the Sunnes Altitude, which admit you find her upon the Meridian of 84. deg. 00. min. above the Horizon, which I subtract out of 90. deg. 00. min. and find the Sunne distant from my Zenith 6. deg. 0. min. Therefore now according to the Rule, subtract 6. deg. 0. min. from 23. deg. 30. min. the declination of the Sunne that day, and the Latitude or breadth that *St. Christophers* is from the Equinoctiall remaineth, which is 17. deg. 30. min.

Manner of Worke.

	deg.	min.
T He whole quantity of your Quadrant, is	90	00
The Altitude found by observation, is	84	00
The Zenith distance, is	6	00
The declination of the Sunne, is	23	30
The Zenith distance subtr. from the declination Lat.	17	30

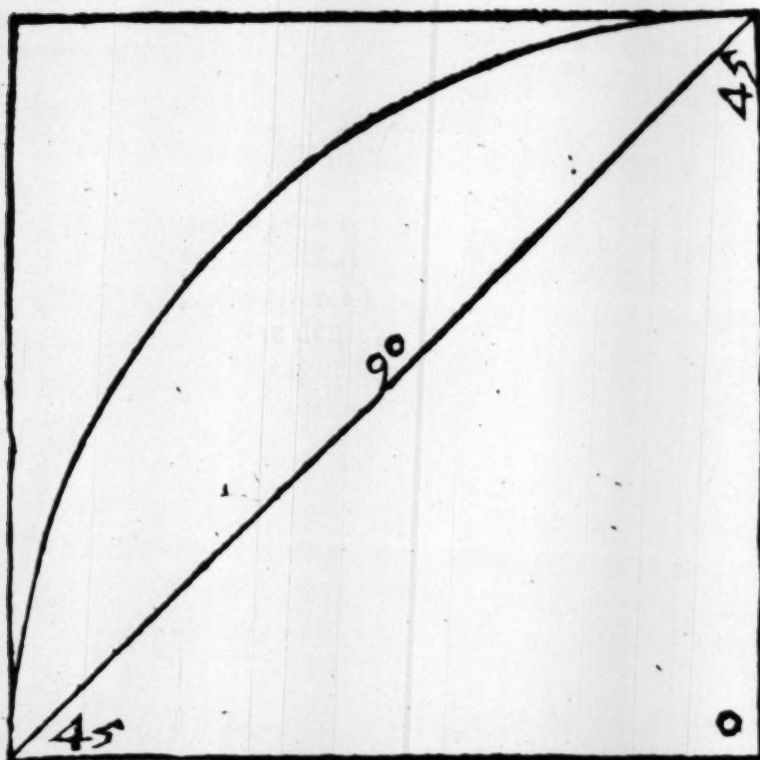
Having the Sunne or Perpendicular in any place found by observation, the declination of the Sunne is the Latitude of the

the Place: But if when you have the Sunne in your Zenith Poynt, your Ephemerides or calculated Tables giveth no declination, then conclude, that the Equinoctiall Circle runneth through your Zenith Poynt, And that you are in no Latitude or breadth from the Equinoctiall, because you are just under it.

The reason of taking Altitudes.

HAVING shewed the manner of working your observations of the Sunne, howsoever your Zenith Poynt is situated whereby you may come to the true knowledge of your Latitude or breadth from the Equinoctiall and Poles, it now resteth, that I should shew reason for that which is produced by the operation of your Geometricall Instruments; therefore you must in the first place conceive the Nature and quality of your Instrument, with w^{ch} you observe or take the Altitude. Know then that all manner of Instruments of what forme so ever projected, as Grosse-staves, Back-staves, Quadrats, Astrolabes, &c. are all of them according to Geometricall measuring the exact fourth part of a Circle containing 90. deg. 00. min. and resolving by their Angles the same thing that the Quadrant and Astrolab doth with their Arches. Now then if we define the Nature of observation by the Geometricall Arch, the reason of all observations of Altitudes taken with any kind of Instrument, will be explained.

First then, *Quadrant* signifieth a Square and Arcusse, a portion or part of a Circle, which if it be swept in a Square or equall Paralelogrames, one foot of your Compasses standing in any of his Intersections, and the other extended the length of either his sides, making that distance his Semidiameter, the Arch is as great as possible may bee contained in such a Square; And a subtending side or base being drawne from the extreame intersections of the Arch with the Sides, will make the Square equall to two Rightangled *Isofcholes*, as this Figure representeth.

The Figure.

Now then it is plaine, that the Rightangle of *Isofcheles* is alwayes equall to his subtending Side or base, which here you se intersecteth the Arch, and the two containing sides at two places, and maketh his two Accute or sharpe Angles equall 45. a pice, so you see the Arch is equall to the Right angle, and the two Accute Angles will make an other Arch of like quantity, which being adjoyned, is an exact Semicircle, so then it resteth, that the Quadrant used in observation, is the greatest Arch of a Circle that is possible to be described within an equall Paralelogrames, which will alwayes be the exact fourth part, if your Paralelograme be without fault; and therefore

therefore is very properly called a Quadrant. Therefore now finding that my Geometricall Arch, which I observe withall is equall to the Right Angle of *Isosceles* it may most easily draw these Imaginations into your mind.

First.

THat in what place soever you are, either on shoare or at Sea, that the poynt which you rest upon is the Center of a Semicircle, and the opposite poynt in the Heavens is your Zenith, from whence if a Perpendicular line were let fall, it would be the Semidiameter of the Semicircle.

Secondly.

THat being thus in the Center with your Zenith Perpendicular, you can turne no way, but if you observe your visuall Line to the Horizon, and remember your Zenith Perpendicular, the Arch of the Heavens contained is equall to your Geometricall Arch projected.

Thirdly.

THat there is nothing contained within your Horizontall Circle, whether it be in the Heavens, or arise from your Superficies, except onely your Zenith poynt, but your visuall Line will shew that it is a part or portion of the contained Arch.

Fourthly.

THat all visuall Lines except your Zenith and Horizon, intersecteth an Accute or Sharpe Angle with your place of being or Center.

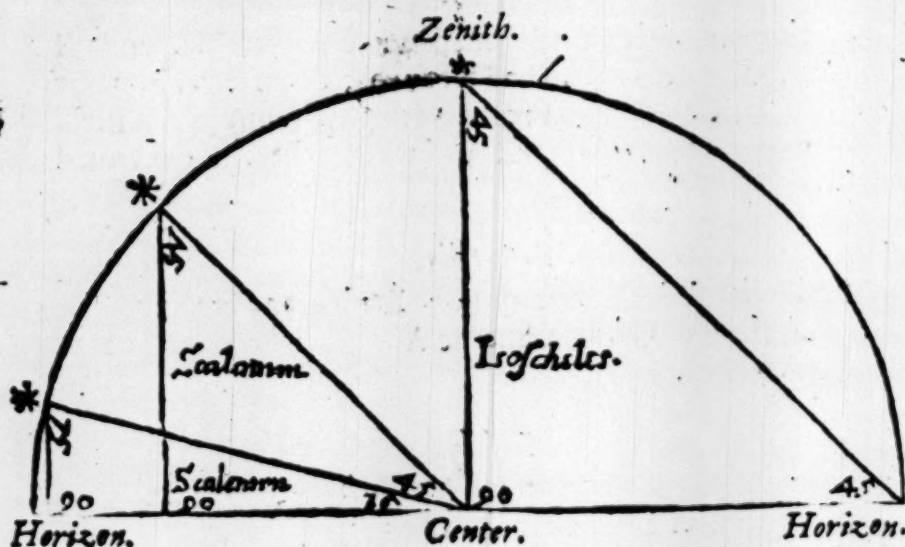
Fifthly.

THat this Accute or sharpe Angle being once knowne, which your visuall line maketh with any body observed, and that you suppose a Perpendicular line to fall from the intersection of the body (and visuall Line) to the Superficies where-

wherein you see, that perpendicular is the Altitude of the Body, and will intersect your Horizontall visuall line, at a right Angle, and the visuall line at the body with an Accute or sharpe Angle, which is alwayes in quantity as much as the knowne Accute wanteth of 90 deg. 00. min. and is the exact distance of the body observed from your Zenith Poynt.

Sixtly.

Sixtly and lastly, you may now plainly perceive, that I can observe the Altitude of no visuall body with any Geometricall Instrument, but if you observe the former reasons you will have a Rightangled Triangle given with all his Angles knowne; because your Instrument will give the visuall Accute Angle from your Center to the body, and then the other Accute is his complement or so much as it wanteth of 90. deg. 00. min. (and the third is alwayes a Rightangle) so that if an expert Artift should demand a reason of your observation, you may answer him, that you are to resolve a Right-angled *Scalenum*; except you find a Zenith Altitude, and then you shall have Rightangled *Isofcheles*.



This Figure sheweth all plaine- if well observed, which before was but imagined : And if you consider it aright, and according to my intent you may proceed and take your observations (not as commonly they are taken) but according to an Artist, knowing what you have done.

Of the plaine-Card.

AFTER all the afore mentioned matters of Navigation are fully understood by the Industrious Practitioner, the plaine-Card would most willingly produce his operations, but in regard his Linements will not answer the reall truth in the prosecution of long Voyages, I would not have your expectations frustratred with relying overmuch upon his conclusions ; for there are many facill and farre better wayes of accompting all manner of Courses and Traverses, by the aid of Arithmeticke and the application of one of the greatest Circles described upon the Sphearicall body of the Terrestrial Globe, which heereafter in the ensuing worke will be manifested : Yet I would not have any man mistake my meaning, and conceive that I utterly condemne all Charts in *Plano*, as Instruments of no consequence, for in all short Voyages I doe allow of them, yea and highly approve of them, as the most excellent Directors. As heere in the *Sleene* or Channell betwixt the West Countrey and *France*, there is no like Instrument as the Channell Chart of the largest graduation, and likewise in the *Irish* Seas, and so upon the Coast of *Flanders*, and in generall, in all Inlets, Straights, and Channels (provided) that the Hydrographicall descriptions of the Seas, and the Geographicall of the Lands have beene laid downe by an experienced Artist, but if they have any larger extentions, I must ingeniously confesse, I shall little or nothing at all regard their directions, because it cannot appeare any thing difficult, for the meanest Marriner to conceive, that according

to the Meridians described upon all Terrestrial Globes, the plaine-Chart will be found to be most intollerably false, for according to the Globe, all Meridians will intersect each other at the very Poynts, which we terme the Poles; but the plaine-Charts make them all to be Paralels in all Latitudes, then which nothing is more false; and againe, all the degrees of Longitude are false in all Latitudes, except right under the Equinoctiall, because the Meridians and Paralels hold not their proportions as they ought to doe, and therefore it must needes be, that all Courses or Rombes will faile in their directions. And so all his Lynements will be found lame, increasing to greatest Error as you are farre Northerly or Southerly, and therefore may not be over much followed if you will have your conclusions crown'd with credit. As for the manner of using your Channell-Chart is so facill, that at the first demonstration common sence will discover all his lynements and uses. Therefore I will save the Labour of defining him in particular, referring you to any Channell Chart that is well described, whereby you cannot bee long in conceiving all his parts in generall.

Of the distance of Places.

TO Saile the most direct course betwixt any two places Assigned, and to discover the most compendious or shortest distance in Degrees, Leagues, and Myles or any other kind of Measure that shall be desired, will require some better knowledge then the use of the plaine Chart, with his (Paralell Meridians) and in all Paralels equall degrees of Longitude and Latitude: For surely the intelligent Artift, cannot be so stupid as that he should take the distance discovered by such an Instrument, and conclude that it produceth the reall truth, for the afore-mentioned reasons will sufficiently satisfy, that no such matter may be expected in any great distances: Yet I know there is many will labour much to prove the plaine Chart, most infallible and certaine in his operations, but

but their many lame conclusions I dare affirme, doth secretly checke most of them in theyr conscience, especially if the course have not Elevated or deprest the Poles over-fast; but that the Longitude hath had a farre larger proportion then the Latitude, as in many severall long Voyages I have seene the experience and prooffe of their reckonings, which have wholly kept them according to their plaine Charts directions: Amongst many, I will resite one passage that happened whilst that I sailed with the *Hollanders*, which many English and Dutch yet living will affirme to be most true, we had two Yachts or small Ships of the *West-India* Companies, a boord of whom we had both Dutch and English Officers, that professed the Art of Navigation. Wee had our Commission to discover the Islands of the *Lucayas*, where having beene some foure Moneths in very much danger, and great store of foule weather, we found that wee were something to the Northward off an Island called the *Vcanes*, which lyeth in the Latitude of 27. deg. 30. min. and finding that the *Golph of Balhama* set us off to the N. E. and so haust us out from amongst the Islands, it was agreed, that we should beare up the Helme to goe home: you must understand, that from this Island wee shapt our course for *Flowers*, one of the *Wester* Islands, lying in the Latitude of 30. deg. 30. minutes, and to the Eastward of the *Vcanes*, according to most exact accompt, (as I did calculate) 800. English Leagues, but by the plaine Charts much more; when wee first stood away our course from amongst the Islands, I then told all those that kept their accompts according to the Charts in *Plane*, that by this runne of so many hundred Leagues, and raising the Pole not above 12. deg. 00. min. they should plainly perceive the Errors of that Instrument; but because most of them had no other meanes to helpe themselves, they stood in his justification, and onely I in his condemnation; wee proceeded in the course, and kept all our accounts most secret from each other, untill the matter came to be discovered, for when I had runne out the Leagues of Longitude, contained

betwixt the aforesaid places, according to my calculation, I did not use the old Sea course of keeping my account secret untill we saw the Land, for then I well knew there would be no bad reckonings produced, but according to my observation finding that my Latitude and Longitude had transported me very neare the place of expectation: About setting of our watch I plainly and openly spoke, that if the Gale held but so as it did untill morning, we should be close aboard the Islands of *Flowers* and *Cornes*; these speeches thus spoken, made a mighty confusion amongst all our Artifts in generall, so that some of them hoping to have had the credit of the cause openly affirmed against me that it was impossible to be so neare the Land, and that wee must runne yet 150. Dutch Myles, which is 500. English Leagues before wee should see the Land, and so they all in generall concluded wee were so farre distant, some of them being 150. Dutch myles, some 140. some 130. but none of them nearer, in the Night time we spoke with our consort, and it was quickly advertised what I had said; but he held it impossible, and concluded neare upon the same matter as they did aboard us, and so I was condemned of them all in generall. Yet there were some English and Dutch, that having little knowledge themselves, did relie more confident in my conclusion, because in former affaires they had bin eye-witnesses that they had truly answered their expectations, whereupon the matter grew to wagers, with much advantage against me; it was strange to see how resolute they were against their reputations, and how obstinate in their opinions; Yet were not able to render a reason, the Morning came and it was very heafie untill betwixt 9. and 10. of the Cloke when it cleared up, and now you may bee sure the tops would not want some to looke abroad: the first that adventured saved the rest a labour, and shewed us Land right a head, about some three Leagues off, to confirme the truth of the matter, we did but step forward and under the Litch of the Foresaile were eye-witnesses, as any man that knoweth those lands wil easily conjecture, that it

It must be very thicke weather, if at that distance wee should not discover them upon our decks: this reall truth produced, made them all fall a wrangling at their Charts as most erroneous and false, and now the most intelligent men began to desire meanes for the amendment of so grosse a fault, upon which occasion, I did then promise, that if occasions would permit, ere it were long they should have the same way of accompt, which I used for all manner of Voyages, so plainly discovered both to them and all others, that if the Course were never so long and difficult, in regard of Shifts of winds and traverſes. yet the true poynt of the Ships beeing should be certainly knowne, to the Industrious Practitioner how it was Scituated, in respect of all parts upon the Terrestiall Globe. This hath and is the chiefe cause that the ensuing Worke is now divulged to publicke view, for I could well have kept it as yet in my owne brest to my particular Benefit, and saved a great deale of Labour in unlocking and laying open all my Treasure to bee freely shared amongst my Friends. But that I have ever held my promise if possible, should be performed. And now I heartily wish, that although I have dispersed the Key in common amongst them, that they may all finde an everlasting Treasure to satisfie their expectations.



CHAP. I.

*The way of Sayling by the Arch of the
greatest Circle extended*

THe most excellent way of Sayling, is by the Arch of one of the great Circles applyed or extended, betwixt any two places upon the Terrestiall Globe, by which directions you will not onely saile the most compendious course that is possible, but shall likewise be able to keepe a more exact account of all manner of courses that you can by any other kind of meanes, and shall be assured of the certaine poynt of your ships being: But it is most necessary before you proceed to the manner of worke, that you should understand the Nature of all Courses betwixt any two places assigned: Therefore the intelligent Artist cannot but conceive at the first sight of any Terrestiall Globe, that all places howsoever situated must in respect of the Spherical body, containe a part or portion of a Circle betwixt them. Now then the greater Diamiter that the Circle hath, the lesse Curue or crooked will his arches bee. Therefore if wee will find the most direct course, it must be performed by one of the greatest Circles described upon the Globe, and extended betwixt any two places assigned; which extention and none other will give you the exact quantity of Degrees, Leagues, or Myles, that is contained betwixt them, as it appeareth by the graduated Quadrant belonging to all Globes, which is the exact fourth
part

part of the Meridian or Equinoctiall, which are Circles of the greatest capacities; that Quadrant being extended betwixt any two places, sheweth the true distance; But to find this portion or part contained without the Terrestrial Globe, will require the consideration of divers matters. And because, it is most proper to explaine their reasons before the operation, that the judicious practitioner may be assured in the certainty of his Conclusions; therefore we will begin, and first take into our consideration the nature of all Diameters and Semidiameters.

Diameters and Semidiameters.

ALL Diameters and Semidiameters of the Globe, beare proportion each to other, and the same proportion that one Diameter or Semidiameter beareth in respect of another, the same proportion will theyr Circumferences have to each other.

The Signes of Latitude.

THe signes of any Latitude, are the perpendiculars that are supposed to bee let fall from any Degree of the graduated Meridian in the terrestrial Globe, and doth Intersect the Diameter of the Equinoctiall at right Angles, and the signe of the Complement of any Latitude, is a perpendicular, that is supposed to intersect the Diameter of the Meridian at right Angles, and is ever the Semidiameter of that Paralell.

Parallels.

THe Signes of all manner of Latitudes being Perpendiculars, intersecting the Diameter of the Equinoctiall at right Angles, must of necessity be Paralels to each other, and so are likewise the Signes of theyr Complements.

Proper-

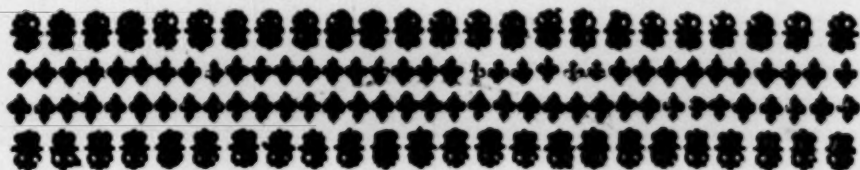
Proportion of Circles.

ALl Paralell Circles upon the terrestiall Globe hold a certayne proportion with the Meridian, and the same proportion that the Paralell hath to the Meridian, the same proportion will theyr Diameters and Semidiameters beare each to other.

As for Example, in the Paralell or Latitude of 60. degrees 00. min. the whole Circle is but halfe so bigge as the Meridian; and therefore, a Degree of that Paralell is but halfe the Magnitude of a Degree in the Meridian, and so in like manner, the sine of the complement of that Latitude, or the Semidiameter of the Paralell, is but halfe the quantity of the Semidiameter of the Meridian.

Circular Courses.

THere is no Rumbe or Course which you can keere, by the direction of any of the poynts of the Compasse, which will transport you the nearest way betwixt any two places assigned, but onely East and West right under the Equinoctiall, and North and South which is under a Meridian; for all other Courses produce not one of the greatest Circles; and therefore the Arch contained is more curue or crooked then it would be, if an arch of the Meridian or Equinoctiall were extended betwixt them; and therefore cannot possible be the most direct Course that may be found.

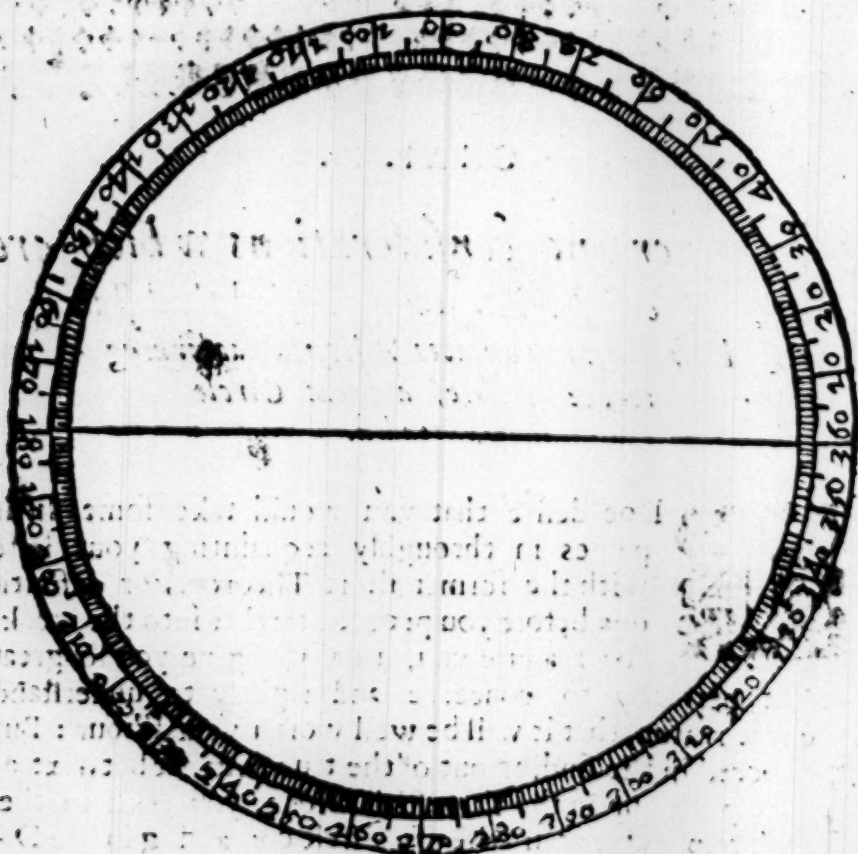


CHAP. II.

*The order and considerations w^hich are
to be observed when you are to find the distance
betwixt any two places Assigned, according
to the Arch of a great Circle
extended.*

I Doe desire that you would take some little
paines in thoroughly acquainting your selfe
with the former short Theorems or definitions,
before you proceed farther into the work.
For I assure you, they will give you so great
a light perfectly to conceive and rightly to understand
the true reason, that it will be well worth your labour: But
to proceed in the finding out of the true Distance betwixt a-
ny two places upon the Terrestiall Globe, you must in the
first place, provide your selfe of a Circle containing in the Di-
ameter, about some 12. Inches, for if it be smaller, the degrees
will be so little that halfe a degree will be of no consequence,
which is tenne Leagues in distance; therefore the larger the
better, this Circle must bee divided most exactly into 360.
degrees equall parts, with figures set to each 5. degrees, for
the readier numbring, and so proceed untill it make 360. deg.
which concludeth the whole Circle, as this Figure follow-
ing plainly expresseth.

The Figure.



The material that it should consist of, should be of Brasse or well-plained board; but for want of those, you may describe it upon good pastboard: after your Circle is completely divided, you must understand, that it doth represent the Equinoctial Circle described upon all Globes; and therefore is a Circle of the greatest Diameter: when this easie Instrument is projected and framed, you may proceed and find the true distance betwixt any two places, if you will first take notice of these following observations.

First

First Observation.

First consider, that if the two places which are assigned you to give the true distance according to the Arch of one of the greatest Circles, should be both of them Situated to the Northwards of the Equinoctiall, and that they should have one and the same Longitude, then reason will resolve the Question without any farther worke, but onely subtracting the lesser Latitude out of the greater, and the true distance will remaine, because the arch contained betwixt them is a portion or part of the Meridian, which is a Circle of the greatest Diamiter, therefore sheweth the true distance: As for Example.

Question.

I Demand, the true distance according to the Arch of one of the greatest Circles that is contained betwixt the Island called *Island*, and the Island called *Fero*, one of the *Canarie* Islands.

Here in this Question, first I consider that both places lye in Northerly Latitude, namely *Island* in 66. deg. 00. min. and *Fero* in 28. deg. 00. min. then I consider the Longitudes of the aforesaid places, and it appeareth, that they are both Situated under one Meridian, which is a Circle of the greatest Diamiter; therefore according to the former directions, I subtract the lesser Latitude out of the greater, and the Arch contained betwixt them remaineth: As for Example.

The Latitude of <i>Island</i> , is	deg. min.
66	00
The Latitude of <i>Fero</i> , is	28
28	00
Remeth after subtraction	38
	00

So it plainly appeareth, that the true distance betwixt *Island* and *Fero*, according to the Arch of one of the great Circles contained betwixt them, is 38. deg. 00. min. which

is soone turned into Leagues or Myles, onely by multiplication; for if you multiply 38. deg. 00. min. by 20. which are the Leagues in one degree, either of the Equinoctiall or Meridian, the product yeeldeth the leagues contained betwixt the aforesaid places, and if you will multiply those leagues by 3. you have the Myles; therefore it is most manifest, that *Iceland* is distant from *Fero*, one of the *Canary* Ilands, 38. deg. 00. minutes of the Meridian, or 760. leagues, or 2280. Myles.

Second consideration.

SEcondly you must consider, that if two places bee assigned you to give the true distance according to the Arch of one of the great Circles contained betwixt them, and that one place lyeth to the Southward of the Line, and the other place is Scituated to the Northwards of the Equinoctiall, and yet that both of them should have one Meridian; then onely adde the Latitudes of both places into one summe, you have the true distance in degrees and minutes, which you may turne into degrees or Myles as I shewed before, and by the following Question is manifested.

Question.

I Demand the distance, according to an Arch of one of the greatest Circles, that is contained betwixt *Fayall*, one of the *Wester* Ilands, and *Cape Frio* in *Brazeele*.

In this Question, I first consider the Latitude of both places, and I find that *Fayall* is Scituated in the Paralell or Latitude of 39. deg. 00. min. to the Northward of the Equinoctiall, and that *Cape Frio* in *Brazeele*, hath 22. deg. 00. min. of South Latitude, now in regard both places have one and the same Longitude, I onely adde or joyne both Latitudes into one summe, and I have the degrees of the Meridian that is contained betwixt them: As for Example.

Fayall

	deg.	min.
<i>Fayal</i> hath North Latitude	39	00
<i>Cape Frio</i> hath South Latitude	23	00
Both added into one summe maketh	62	00

Which is the true distance in degrees of the Meridian or Equinoctiall that is contained betwixt the aforesaid places, which turned into Leagues, maketh 1260. and in Myles amounteth to 3660.

Third Consideration.

THirdly you must consider, that if any two places be assigned to give the Arch of one of the greatest Circles contained betwixt them, and consequently they are true, and that both places are scituated right under the Equinoctiall, then you may onely observe the difference of their Longitudes, and that is their true distance; because the Equinoctiall is a Circle of the greatest Diamiter, but you must ever note, that if the degrees of Longitude amount to more then 180. then subtract them from 360. and the true distance of degrees contained betwixt the aforesaid places will remaine: As for Example.

Question.

I Demand the distance, betwixt *S^t. Thomas* Island, which lyeth right under the Equinoctiall, admitting that it hath 35. deg. 00. min. of East Longitude, accounting from the Meridian that passeth by the Islands of *Cape Deverte*, and the mouth of the River of *Amazones*, which is likewise Scituated under the Equinoctiall, and is allowed to have 325. degrees of Longitude, accounting from the aforesaid Meridian.

Here in this Question, I onely note the difference of Longitude, and it appeareth that *S^t. Thomas* Island hath 35. deg. 00. min. of East Longitude, which because all degrees of

Longitude, which because all degrees of Longitude ever begin their first account Eastward, I onely reserve that summe untill I have subtracted 325. deg. the Longitude of the River of *Amazon*, from 360. deg. the beginning and ending of all Longitudes, and there remaineth also 35. deg. 00. minutes, which I adjoyne to the 35. deg. 00. min. of East Longitude where *S. Thomas* Islands is situated, and they both make 60. deg. 00. min. which being turned into leagues, make 1200. and in myles, amount to 3600. which is the true distance of the aforesaid places according to the plaine of the Equinoctiall extended betwixt them, which is a Circle of the greatest Diameter. All these Questions hitherto, have no difficulty in finding the Arch of the Circle contained betwixt them, because their proper courses are all of them under Circles of the greatest Diameters, and therefore are soone resolved, onely with the helpe of Addition and Subtraction; Yet I could not omit them as matters of no consequence, in regard I am certain the Industrious Practitioner doth ever desire fully to understand every particular as he proceedeth.



CHAP. III.

*How to find the true distance, according to
the Arch of a great Circle extended betwixt
any two places, howsoever
Situat.*



After all the former considerations are fully understood, you may proceed by the ayde of your great Circle formerly described, and take the true distance that is contained betwixt any two places howso-

howsoever scituated; the first thing that you must take in hand whereby you may prosecute the premises, is the graduated Circle, containing 360. degrees; from the Center of which Circle you must take betwixt a paire of Compasses the exact Semidiameter, accounting from the Intersection with the outwardmost Circle of the two, that containeth the single degrees betwixt them, and with the same extension upon any plaine and cleane sheet of paper, describe another Circle of the same magnitude, then take your ruler and draw a Diameter at pleasure, running directly through the Center; at the Intersection of this Diameter with the Circumference, ever towards the right hand, set in figures 360. degrees, representing the beginning and ending of all manner of Longitudes, and so you are now completely ready to resolve any kind of distance that you shall desire, if you observe the nature of the scituation of both places, which may be in foure severall respects or kinds, which I will here briefly explaine, that the judicious Practitioner may at any time be deceived in mistaking the manner of work, for he must understand that upon these foure severall Scituations, there arise foure severall sorts of worke, which if you should mistake one for another, it would breed great Error and shame to your conclusions; but if you with carefully mind the manner of worke, which is hereafter observed upon the general Scituations, you will never faile, for you may assure yourselfe that there can no Question happen; but it will either fall out according to one of these foure Scituations, or else in respect of the already considerations formerly manifested.

First Scituation.

First, one place may be right under the Equinoctiall, and so hath no Latitude, and yet may be in many severall degrees of Longitude, accounting from the Meridian that intersecteth the Equinoctiall at 360. deg. which is the beginning and ending of all manner of Longitudes, and the other place may have

have both Latitude and Longitude, yet differing from the first places Longitude.

Second Scituation.

SEcondly, two places may differ both in Latitude and Longitude, and yet may be both of them Scituated either to the Northwards or Southwards of the Equinoctiall.

Third Scituation.

THirdly, two places may differ both in Latitude and Longitude, and one place may be Scituated to the Southward of the Equinoctiall, and the other to the Northward.

Fourth Scituation.

FOurthly, there may be two places Scituated in divers Paralels or Latitudes betwixt the Articke and Antarticke Poles, that may both of them have one Degree and Minute of Latitude, yet may have severall degrees of Longitudes.

These are the Scituations of all places upon the Terrestiall Globe, so that there cannot be any two places but in respect of each other, they will be found in one of these foure kinds, except they fall in the former Considerations, which have beene at large explained unto you; therefore, if you will seriously observe these short directions, and then if you make application at all times according to the manner of worke performed in the following Questions, you shall never have your expectation deceived.

*First Question, according to the first
Scituation.*

I Demand, the distance betwixt the Eastermost part of the Mouth of the great River of *Amazones*, which is Scituated
right

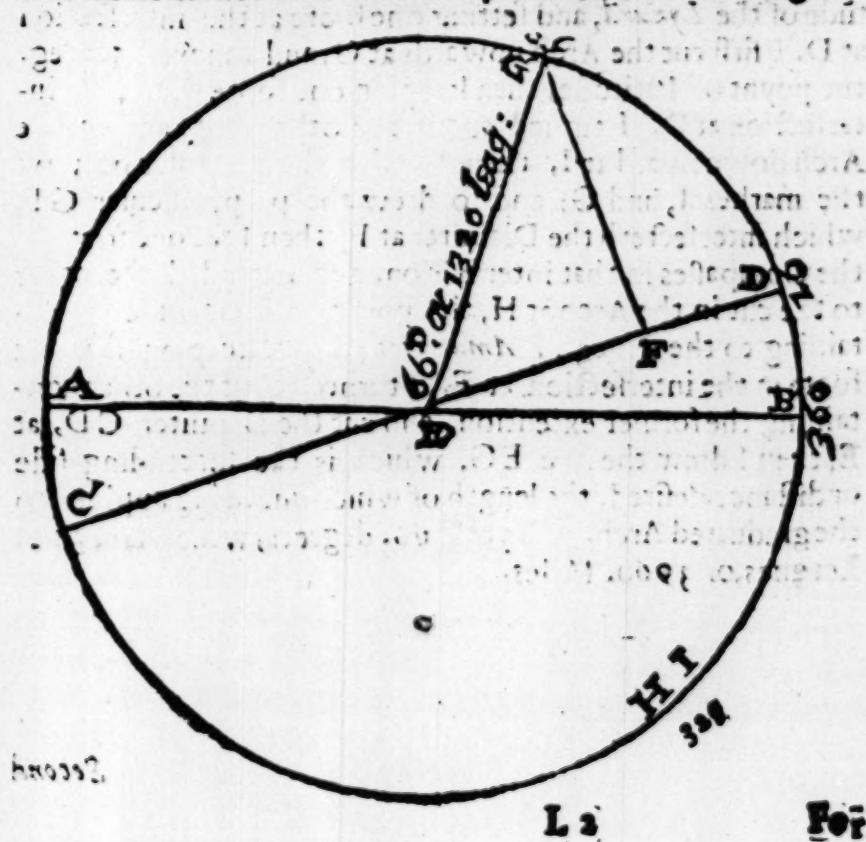
right under the Equinoctiall in the Longitude of 325. deg. and the Head-land in the West of *England*, called the *Lizard*, Scituated in the Latitude of 50. deg. 00. min. and 16. deg. 00. mi of Longitude.

Now it is most apparent, that these two places are according to the first Scituation, and therefore the manner of worke in this Question, will serve as an Example for all other of like Nature. First, then having swept a Circle of the same magnitude that your graduated Arch is of, draw a Diamiter through the Center (at pleasure,) intersecting the circumference at two certaine places, the one towards your left hand, and the other towards your right; at the end of that intersection which is towards your right hand, set in figures, 360. deg. representing the beginning and ending of Longitude; then consider the Longitude and Latitude of both places severally, and you will find the Longitude of the River of *Amazones*, is 325. degrees; but because it is Scituated right under the Equinoctiall, you neede not draw any Diamiter from his poynt of Longitude, onely set one foote of your Compasses right in the intersection of the Diamiter, with the outwardmost Circle of the two in your graduated Arch, (that containeth the single degrees betwixt them) and where you see 360. deg. annexed, extending the other foote downewards in the same Circle, untill it cut just the degrees of 325. deg. the Longitude of the place assigned, now keepe the same extention, and transferre it into the plaine Circle which formerly you drew of the same maguitude, setting one foote of the Compasses in the intersection of the Diamiter, with the Circumference towards the right hand, where you see 360. deg. annexed, and extending the other foote downewards in the Circle untill you have made a marke in the Arch, representing the poynt of Longitude of the mouth of the River of *Amazones*, and then set out against that marke the degrees of Longitude in figures, namely 325. deg. then take your Compasses and returne againe to the graduated Circle, and set one foote in the former intersection, name-

ly where the Diamiter intersecteth the outwardmost Circle on the right hand, where is set in figures 360. deg. then consider the *Lyzards* Longitude, which will appeare to bee 16. deg. 00. min. therefore extend the other foote of your Compasses upwards in the graduated Circle, untill it poynt or cut just in 16. deg. 00. minutes, now transerre that extention into your plaine Circle of the same magnitude, setting one foote in the intersection of that Diamiter, with the circumference towards your right hand, where you see 360. annexed, and turne about the other foot upwards in the Arch, and there make a marke or poynt, setting out against it 16. deg. representing the degree of the *Lyzards* Longitude, from which marke or poynt, because the *Lyzard* hath also Latitude; you must draw a Diamiter running directly through the Center of the Circle, then in regard the *Lyzard* hath Latitude, namely 50. deg. 00. min. therefore you must returne againe to your graduated Circle, and setting one foote of your Compasses in the former intersection, at 360. degrees extend the other upwards, untill it cut or poynt right with 50. deg. in the Arch, then transerre the same extention into your plaine Circle, setting one foote of the Compasses in the intersection of the *Lyzards* Diamiter with the Circumference; namely, where you see 16. deg. annexed, the poynt of the *Lyzards* Longitude; and turning about the other foote, cut your plaine Arch at two certaine places; now lay a straight Ruler to those cuts or markes, and from the *Lyzards* Diamiter upwards draw a straight line, which will stand perpendicular as it ought, and at the intersection which the circumference sheweth the poynt, of the *Lyzards* Latitude, therefore against that intersection, you must set out 50. deg. representing the same matter.

Now from the intersection of this perpendicular with the *Lyzards* Diamiter, extend the Compasses untill one foote standing in that intersection, the other foote doth poynt in the Circle with 325. d. the poynt of Longitude of the River of *Amazones*, then keeping one foote still in the former intersection,

terseccion, turne about the other foote which poynted to 325. deg. in the Circle, and carefully keeping the same extension, cut or make a marke in the *Lyards* Diamiter, then lay a straight ruler from that marke to the *Lyards* poynt of Latitude in the Circle, namely where you see 50. deg. annexed, and draw a straight line betwixt those two places which is the subtending side or distance desired; therefore taking the length of that line betwixt your Compasses, and applying that extension to the graduated Circle, you will have the degrees and minutes of one of the greatest Circles that is contained betwixt the aforesaid places, which if you turne into Leagues and Myles by Multiplication, you have your full desire; and in this Question, you will find 66. deg. 00. min. which make 1320. Leagues, or 3960. Miles, the manner of this worke is so plainly expressed by the following Figure, that common sence cannot but easily conceive it at first sight.



For first, I swept the whole plaine Circle exactly of the same bignesse of my graduated Arch, as hath beene formerly shewed, then I drew a Diamiter at pleasure running through the Center, as A B, then at A, I set 360. deg. and brought from my graduated Circle betwixt my Compasses, the distance of the mouth of the River of *Amazones* Longitude, accounting from 360. deg. in my graduated Circle, and set one foote of my Compasses with the same extent in the Diamiter at B, and with the other I cut the Arch downwards at H, and annexed 325. deg. the degrees of Longitude, then I brought from my graduated Circle betwixt my Compasses, 16. deg. the *Lizard* Longitude, and setting one foot in the intersection at B, with the other I cut the Arch upward at D, and annexed 16. deg. the poynnt of Longitude, and from that intersection, I drew through the Center the Diamiter D. C. then I brought from my graduated Circle 50. deg. the Latitude of the *Lizard*, and setting one foote at the intersection at D. I first cut the Arch upwards at G, and annexed 50. deg. the poynnt of Latitude, then keeping one foote still in the intersection at D, I turned about the other foote and cut the Arch downward at I, then I layd a straight ruler betwixt the markes I, and G; and so drew the perpendicular G F, which intersecteth the Diamiter at F, then I set one foote of the Compasses in that intersection, and extended the other to the cut in the Arch at H, the poynnt of Longitude appertaining to the River of *Amazones*; now keeping still one foote in the intersection at E, I turned about the other containing the former extention, and cut the Diamiter C D, at E; then I drew the line E G, which is the subtending side or distance desired, the length of which line being applyed to the graduated Arch, will yeeld 66. degrees, which is 1320. Leagues, or 3960. Myles.

Second Question, according to the second
Situation.

I Demand the distance, betwixt the Iland in the West Indies called the *Barbadoes*, lying in the Latitude of $13.4.00.$ min. to the Northward off the Equinoctiall, and hath $313.$ deg. of Longitude, and the *Head-land* in England called the *Lizard*, Scituated in the Latitude of $50.$ deg. $00.$ min. and hath $16.$ deg. $00.$ min. of Longitude.

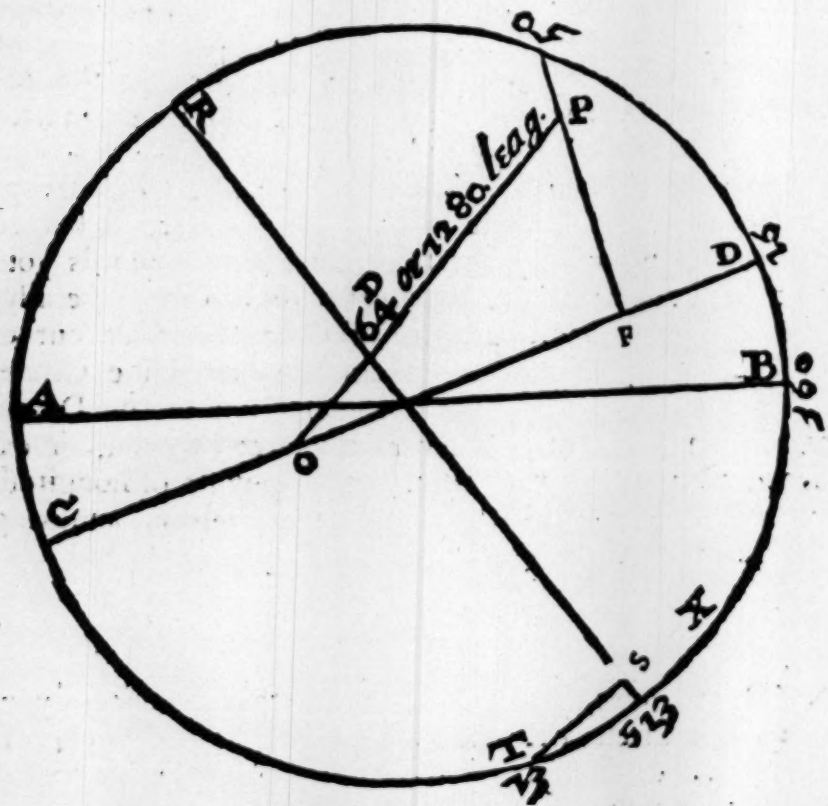
Here in this Question, having your plaine Circle swept with the Diamiter drawn through at pleasure, as before numbered with $360.$ deg. at the intersection towards your right hand, consider the Longitudes of both places severally, which Longitudes with a paire of Compasses take out of your graduated, and transerre them into your plaine Circle, setting one foote alwayes at the intersection of the Diamiter, towards your right hand where you see $360.$ deg. annexed, and with the other foote cutting the poynts of Longitude in the plaine Circle as hath beene shewed before, annexing the figures representing their severall degrees.

Note.

Note alwayes, that you cut the poynts of Longit. in your plaine Circle, after the same manner as you find them in the graduated; that is to say, if the poynt of Longitude exceed $180.$ d. then you must cut that part of the Circle w^{ch} is downwards from the Diamiter, but if Lesse then upwards: as in this Example, the Longitude of the *Lizard* is $16.$ deg. $00.$ min. which is lesse then $180.$ degrees; therefore when you transerre that poynt of Longitude into your plaine Circle, as before, you must cut it upwards in the Circle, also when you cut the Longitude of the *Barbadoes*, in your plaine Circle which is $313.$ deg. and therefore exceedeth $180.$ deg. which is a Semicircle, you must cut that poynt of Longitude under

the arch, or downewards from the Diamiter.

All which, will most plainly appeare, if you judiciously observe this following figure, with the manner of worke continued.



After the poynts of Longitude are transferred and cut in the plaine Circle (as hath beene shewed before,) draw from those poynts of Longitude, two Diameters intersecting each other in the Center, as C D, and R S, then returne to your graduated Circle, and set one foot of your Compasses in the intersection of that Diamiter, with the outwardmost Circle of the two, which containeth the single degrees betwixt them,

them, and where 360. deg. is annexed, extending the other foote to the poynts of both places Latitudes (severally) which extentions, transferre into your plaine Circle making them to stand perpendicular from their Diameters of Longitude, and intersecting the plaine Circle at theyr poynts, or signes of Latitude; as for Example, take 50. deg. betwixt your Compasses, the Latitude of the *Lizard*, and with the same extention returne to your plaine Circle, and there observe where the Diameter of the *Lizards* Longitude intersecteth the plaine Arch, which you will find is at D, therefore set one foote of your Compasses in that intersection, and extend the other first upwards, and cut the Circle at G, then turne about the Compasses keeping still one foote in the former intersection, and retaining the same extention, cut the Arch downwards at X, then lay a straight ruler to the intersections X and G, draw the perpendicular F G. which is the signe of the *Lizards* Latitude, and standeth perpendicular as it ought from his Diameter of Longitude; in the same manner, transferre 13. deg. 00. min. out of the graduated Circle, the *Barbadoes* poynt of Latitude, and make him stand perpendicular to his Diameter R S, by cutting the Arch on both sides with the same extent, namely at T X, and laying the ruler as before, to both those markes or poynts, draw the line T S, which will stand perpendicular from his Diameter, and touch the poynt of Latitude at 13. deg. in the Arch as it ought to doe; then take betwixt your Compasses the distance contained betwixt the intersections of both the perpendiculars with their Diameters, (namely from F to S,) now let one foote still rest in the intersection of the longest perpendicular or greatest Latitude (namely at F,) and then turne about the other foote holding the same extention, and cut or make a marke in the Diameter C D, at O, then take the length of the least perpendicular or signe of Latitude, namely T S, and transferre it into the greatest perpendicular or signe of Latitude by setting one foote of the Compasses in the intersection at G, and carrying the other downwards in the perpendicular

First, sweep the plaine Circle of the same magnitude, of your graduated as the figure sheweth, then draw the Diameter A B, annexing at the intersection at B, 360. deg. then draw as before, Diameters from each places Longitude, as C D, and R S; then as hath beene shewed before, let fall their perpendiculars from theyr poynts of Latitude intersecting their Diameters, as F G, the signe of the *Lyzards* Latitude, and S P, the signe of the River of *Plates* Latitude, then set one foote of your Compasses in the intersection of the greatest Latitude that is at F, and extend the other foote to the intersection at S, now keepe still one foote at F, and turne about the other which was at S, and cut the Diameter C D, at O, and then because one place hath South Latitude and the other North, you should joyn the lesse Latitude to the greater, that is to say, you should extend the signe or perpendicular F G, untill it might also containe the perpendicular or signe S P, but in regard it would extend farre without the Circle, let fall a perpendicular from the intersection at O, and then transferre the signe S P, from O to H, which comethall to one matter, as if it had beene a joyned from G upwards, running without the Circle, and the figure is now more uniforme then it would have beene with that extention; now from the poynts H G, draw the lynes subtending the distance, which if you take betwixt a payre of Compasses and apply to the graduated Arch, will yeeld 99. degrees, or 1980. Leagues.

Fourth Question, according to the fourth Situation.

I Demand the distance, betwixt Cape *Bonivist* in *New-found-land* and the *Head-land*, called the *Lyzard*, both places having neere 50. deg. of North Latitude, Cape *Bonivist* in the Longitude of 329. degrees, and the *Lyzard* in 16. degrees.

the intersection of the Diameter; and from that cut or poynt, draw the Diameter R S. and so in like manner transerre the poynt of the *Lizards* Longitude, and draw the Diameter C D, then as hath beene formerly shewed transerre the poynts of both places Latitudes, and draw the perpendiculars F G, and P T, which cut their Diameters at right-angles, from which intersections draw the line F P, which is the subtending side or distance, and in this Question if you take that line betwixt your Compasses, and apply it to your graduated Circle, it will there yeeld you 29. deg. 00. min. which is 580. Leagues, or 1740. Miles.

These Questions which have beene already fully explained, both by Figure and Worke, cannot possible seeme any thing difficult to the industrious, but rather with small practice will prove most facill and delightfull in operation, all things being already so plainly demonstrated, and perfectly drawne forth for the obtaining of the true knowledge in all manner of distances, what may be the portion or part of one of the greatest Circles contained betwixt them; by which portion the true distance in any kind of measure is produced, as hath beene formerly expressed and sufficiently explained, so that it is needlesse and unnecessary to take farther paines in demonstrating the way of finding the true Distance betwixt any two places, according to the application of one of the greatest Circles, because by the former questions, if at any time there should arise any doubt in your worke, you may be resolved; if according to the Scituation of your places Assigned, if you have relation to these former questions, and there make application according to the manner of worke produced, you can neither faile nor find fault.

Now after you are able to find the true distance of any two places (each from other) that are Scituated upon the Terrestrial Globe, you should in the next place learne to know upon what poynts of the Compass you must prosecute the Course according to the plaine of the great Circle extended; but in regard that it requires the certaine knowledge of the quan-

title of each severall Angle, than the portion or parts of the greatest Circle maketh with each severall Meridian, other-
wayes you cannot faile the most direct Course, although you
find the true distance by the former Rules; the positions of
which Angles are so subtil, and will seeme so obdurate to
many Seamen, that they will not endure to take so much
paines as is required in the resolving of them, according to
the doctrine of Tryangles. Therefore I have devised a more
facill way for the performance of the premisses, onely by the
rules of Proportion, and the ayde of my Tables here inser-
ted; the use of which Tables with the rules of Reduction,
and divers other reasons and observations; you must be well
acquainted with all, before you can apply the rule of Three or
proportion to find out your desire: First then, we will begin
and draw forth our Tables of Longitudes.

The Table of Longitudes which I have Calculated, containing the Leagues, Miles, and Staves, that make a Degree in any Parallel, betwixt the Equinoctiall and the Poles.

10. Leagues.

Latit.	leas	M	Staves.	Latit.	leas	M	Staves.	Latit.	leas	M	Staves
1	19	2	994	31	17	0	431	61	9	2	89
2	19	2	964	32	16	2	886	62	9	1	189
3	19	2	922	33	16	4	322	63	9	0	240
4	19	2	856	34	16	1	742	64	8	3	303
5	19	2	772	35	16	1	152	65	8	1	357
6	19	2	671	36	16	0	543	66	8	0	495
7	19	2	553	37	15	2	912	67	7	2	443
8	19	2	417	38	15	2	281	68	7	1	476
9	19	2	265	39	15	1	630	69	7	0	502
10	19	2	90	40	15	0	962	70	6	2	521
11	19	1	898	41	15	0	283	71	6	1	534
12	19	1	691	42	14	2	989	72	6	0	542
13	19	1	462	43	14	1	882	73	5	2	542
14	19	1	218	44	14	1	162	74	5	1	538
15	19	0	959	45	14	0	426	75	5	0	529
16	19	0	681	46	13	2	681	76	4	2	515
17	19	0	383	47	13	1	922	77	4	1	497
18	19	0	63	48	13	1	149	78	4	0	474
19	18	2	732	49	13	0	364	79	3	2	448
20	18	2	395	50	12	2	567	80	3	1	419
21	18	2	17	51	12	1	130	81	3	0	386
22	18	1	632	52	12	0	941	82	2	2	350
23	18	1	233	53	12	0	209	83	2	1	312
24	18	0	814	54	12	2	267	84	2	0	271
25	18	0	409	55	11	1	415	85	1	2	229
26	17	2	927	56	11	0	553	86	1	1	185
27	17	2	461	57	10	2	679	87	1	0	140
28	17	1	980	58	10	1	799	88	0	2	92
29	17	1	479	59	10	0	902	89	0	1	47
30	17	0	961	60	10	0	000	90	0	0	000

The order to be observed in this Table.

THe 20. Leagues which you see placed by themselves in the Front of this Table, sheweth, that 20. Leagues will make one degree of Longitude under the Equinoctiall, then the first Columne towards your left hand, manifesteth the degrees of Latitude beginning at one degree from the Equinoctiall, and ending at 30. d. marked in the Head with (*Latit.*) importing the same thing; the three next Columes towards your right hand, sheweth the Leagues, Myles, and Staves that answer to one degree of Longitude in any of those Latitudes, marked in the head with (*lea. M. Staves,*) the fifth Columne beginneth the Latitude at 31. degrees, extended untill it make 60. degrees, and the three next towards your right hand, shew the Leagues, Myles, and Staves, that answer to each of those degrees; the 9th Columne taketh the Latitude againe at 61. degrees, and concludeth with 90. degrees; the three next and last Columes, shew the Leagues, Myles, and Staves that answer to those degrees; as Example, how many Leagues will make one degree of Longitude in the Latitude of 20. degrees, search for 20. degrees in the first Columne towards your left hand, then right against that Latitude in the three next Columes towards your right hand, you shall find 18. leagues, 2. Myles, 385. Staves.

*The Table of Difference of Longitude in all
Latitudes.*

20. Leagues.

Latit.	lea	M.	Staves.	Latit.	lea	M.	Staves.	Latit.	lea	M.	Staves.
1	0	0	6	31	2	2	569	61	10	0	911
2	0	0	36	32	2	0	544	62	10	1	889
3	0	0	78	33	2	0	678	63	10	2	860
4	0	0	144	34	2	1	258	64	11	0	692
5	0	0	228	35	2	1	848	65	11	1	643
6	0	0	329	36	2	2	457	66	11	2	597
7	0	0	447	37	2	2	1082	67	11	3	577
8	0	0	583	38	2	3	719	68	12	0	534
9	0	0	735	39	2	3	370	69	12	1	498
10	0	0	916	40	2	4	58	70	12	2	479
11	0	0	1028	41	2	4	717	71	13	0	466
12	0	0	1309	42	2	5	417	72	13	1	459
13	0	0	1538	43	2	5	118	73	13	2	458
14	0	1	782	44	2	5	838	74	14	0	462
15	0	1	41	45	2	5	574	75	14	1	471
16	0	1	319	46	2	6	319	76	15	0	485
17	0	1	617	47	2	6	78	77	15	1	503
18	0	1	937	48	2	6	851	78	15	2	526
19	1	0	268	49	2	6	636	79	16	0	552
20	1	0	615	50	2	7	433	80	16	1	581
21	1	0	983	51	2	7	870	81	16	2	614
22	1	1	368	52	2	7	59	82	17	0	650
23	1	1	79	53	2	7	881	83	17	1	688
24	1	1	156	54	2	8	783	84	17	2	729
25	1	2	591	55	2	8	535	85	18	0	771
26	1	2	73	56	2	8	447	86	18	1	815
27	1	2	539	57	2	9	321	87	18	2	860
28	1	2	20	58	2	9	201	88	19	0	907
29	2	1	521	59	2	9	98	89	19	1	954
30	2	2	9	60	2	10	000	90	20	0	000

The

THis Table hath the same order as the former, the 20. Leagues placed in the Front, shewing that so many make one degree in the Equinoctiall, which is a Circle of the greatest Diamiter; the first Colu^mne towards the left hand, shewing the Latitude from one degree from the Line to 30. deg. The fifth Colu^mne, sheweth the Latitude againe from 31. deg. to 60. deg. and the 9th, Colu^mne from 61. untill it conclude with 90. degrees, the rest of the Colu^mnes shew the difference that is betwixt one degree of Longitude in any paralell or Latitude, if it be compared with 20. Leagues, which is a degree in the Equinoctiall, As Example in the Latitude of 4. degrees from the line, your Table sheweth 144. Staves, which signifie, that a degree of Longitude in that paralell is lesse then 20. leagues, which is a degree in the Equinoctiall by 144. Staves lengths; in like manner, if you demand the difference of one degree of Longitude, in the Latitude of 45. degrees, my Table will shew you 5. leagues, 2. myles, 574. Staves, which explaineth, that one degree in that Paralell, is so much lesse then 20. leagues, or one degree in the Equinoctiall.

*The Table of Longitudes which I have Calculated in single
Staves, shewing how many make one Degree in any
Parallel betwixt the Equinoctiall
and Poles.*

60000					
Latit.	Staves.	Latit.	Staves.	Latit.	Staves.
1	59994	31	51431	61	29089
2	59964	32	50886	62	28169
3	59922	33	49322	63	27240
4	59856	34	49742	64	26303
5	59772	35	49152	65	25357
6	59671	36	48543	66	24405
7	59553	37	47919	67	23443
8	59417	38	47281	68	22476
9	59265	39	46630	69	21502
10	59097	40	45962	70	20521
11	58898	41	45283	71	19534
12	58691	42	44589	72	18541
13	58462	43	43882	73	17542
14	58218	44	43162	74	16538
15	57959	45	42428	75	15529
16	57681	46	41681	76	14515
17	57383	47	40922	77	13497
18	57065	48	40149	78	12474
19	56732	49	39364	79	11448
20	56385	50	38576	80	10419
21	56017	51	37810	81	9386
22	55632	52	36941	82	8350
23	55233	53	36109	83	7312
24	54814	54	35267	84	6271
25	54409	55	34425	85	5229
26	53927	56	33553	86	4185
27	53461	57	32679	87	3140
28	52983	58	31799	88	2093
29	52497	59	30902	89	1047
30	51961	60	30000	90	0000

N

The

The Order observed in this Table.

THe 60000. which you see are placed in the Front, shew you that so many Staves lengths in the Equinoctiall, will make one degree; then the first Columnne towards your left hand, sheweth the degrees, of Latitude beginning at one degree distant from the Line, and extending untill it yeeld 30. deg. The second Columnne towards your right hand, produceth the single staves lengths, that are contained in one degree of Longitude, in any of those Paralels or Latitudes: the third Columnne beginneth the degrees of Latitude againe, at 31. deg. and extendeth untill it make 60. deg. the fourth, sheweth the single Staves containd in each of those degrees, the fifth taketh the Latitude, at 61. deg. and concludeth with 90. deg. and the sixth and last, sheweth the single staves that are containd in one degree of Longitude, in any of those Latitudes or paralels. As for Example; If you desire to know how many single Staves in length will make one degree of Longitude in the Latitude of 18. deg. search in the first Columnne, for the Latitude of 18. deg. and in the next towards your right hand you shall finde, 57063. which are the single staves contained in one degree of Longitude in that Latitude: if you require how many will make one degree in the Latitude of 49. search in the third Columnne for that Latitude, and in the next towards your right hand, you shall finde 39364. which answereth the question, &c.

The use of these Tables.

THe many uses that may bee made of these Tables in the famous Art of Navigation, are not more easie then excellent, for all manner of Sea-men, which desire to have their Conclusions crown'd with everlasting credit: For by their ayde and assistance you shall certainly know at all times, in what paralell or Latitude soever that you sayle, the true propor-

proportion of that paralell, in respect eyther of the Meridian, or Equinoctiall. By which you are made able to correct the falsenesse of the Charts in *plano*, which have equal degrees of Latitude and Longitude in all paralels: Also in any course you may finde your distance Meridionall, yeelding such exquisite truth that it shall concurre most exactly with the minute of Latitude, found by your dayly observation: The Account of your ships way is certainly knowne by their ayde and application, let your course be upon any point or points of the Compasse (yea although you were to sayle East or West in a paralell according to your plaine Chart:) The points of your Compasse are found out by their helpe, which you must steere upon in sayling betwixt any two places: The distance betwixt any two places upon the terrestiall Globe in respect of their severall paralels, is straight found out in any kinde of measure; As likewise, if they bee scituated in one and the same paralell or Latitude: also, any number of degrees in any paralell, by the helpe of the aforesayd Tables, are instantly reduced into Leagues, Miles, or single Staves: You may likewise as soone know how many single staves in length, will make one or many degrees in all paralels: Also, any number of single staves, are immediately reduced into leagues, Miles, or degrees of Longitude according to any Latitude desired. The whole Circumference of the Globe in all manner of Latitudes by their helpe is forthwith most truly measured according to the Circular paralels, with infinit other excellent conclusions, which I am certaine the intelligent Seaman will dayly discover, may most facilly be performed by there aide and application rightly applyed and vsed, only in the plaine rules of Proportion, commonly called the Golden Rule, or rule consistig of three Numbers, which no Seaman that taketh charge of conducting a Ship through the Sea, should be ignorant of such easie Arithmeticke. Yet I am certain, there are divers which are not overperfit in those plaine proportions; therefore those which finde theyr Arithmeticke will not well reach to that pitch, may performe

most of the former Conclusions, only with the helpe of my former Tables, Addition, Subtraction, and a little Division, rightly applyed, as the cause shall require; which hereafter shall be manifested, by divers Questions and Examples. But for those men which are altogether ignorant in the use of all manner of Numbers wrought by the Pen, it is impossible for me to give them any instructions, whereby they may gaine any good: Neyther doe I desire to spend my labor in fruitlesse hope, imagining I might beate braines into a Blocke, or turne a Copper Beaker into a gold Cup, I was never so great a Philosopher, neyther doe I intend to trouble my selfe with such Conclusions; therefore such feathered Fowle cannot guild theyr Plumes through my directions: But to the former purpose, you may understand, that these Tables which I have calculated, were drawne forth according to the *Spanish* Accompt, which alloweth $17\frac{1}{2}$ Leagues, to one Degree of the Equinoctiall or Meridian, which is the best allowance according to their proportion, used in drawing forth theyr Leagues, as shall bee proved at large in the next Chapter: which sheweth the Leagues, Miles, and Staves lengths. which you must sayle upon all Courses or Points of the Compass, before you can rayse or depresse the Pole 1 Degree; to which place I referre you for your farther satisfaction, yet in the meane time you may understand, that each Stave is allowed to containe in English measure, ten Foot, Foure Inches, one Barley corne, and one third part of one Barley corne; one thousand of those staves make one English Mile, three thousand one League, and twenty of those Leagues, one Degree, eyther in the Meridian or Equinoctiall (Circles of the greatest Diameter) which punctually answereth the *Spanish* proportion; that alloweth $17\frac{1}{2}$ Leagues in eyther of those Circles, to be one of their Degrees.

The Leagues which you must Saile upon any Course or Point of the Compasse, before you shall raise or depresse the Pole one Degree; and how farre you will be distant from your first Meridian.

THere hath beene very much mistaking the matter, by by divers men, that have undertaken to discover the Leagues in proportion, that answer to each severall Rombe or Course, in raising or depressing the Pole one Degree; the chiefe reason arising, from the diversity of measures which they have made use of in their Calculations: some allowing 5. of our Feet to make one Geometricall pace, one thousand of those paces one Mile, 3. of those Miles one League, and 20. of those Leagues to make one Degree, in the Equinoctiall or Meridian; then which there is nothing more false, for it will not yeild halfe the measure, according to the reall truth that is contayned in 20. Leagues, when it must answer the proportion of one Degree in the Meridian; others againe, doth allow 1700. English yards to make one mile, 3. of those Miles to yeeld one League, and 20. of those Leagues to one Degree of the Meridian; which is likewise most contrary to the true proportion: And so divers others have committed the like Errors; but I trust you will finde my following Table, which I have calculated to that purpose, most precise in the true proportion, which I drew with some paines from from the *Spanish* accompt, that alloweth 17 $\frac{1}{2}$. Leagues to one Deg. of the Meridian; which proportion the *Spaniards* with much tronble and cost, obtained by measuring most exactly upon the Land, keeping ever under their first Meridian, untill by observation they found the Pole rayed or depressed one Degree, which according to their experimentall Conclusion, did most precisely fall out at the expiration of 17 $\frac{1}{2}$. of their Leagues. Now the proportion of those Leagues, they did thus project, or draw forth; 4. Barley Cornes, to make one Finger bredth, 16. Fingers one Foot, 5. of those Feet to make one pace, and 4000. of those paces to yeeld one League, and 17 $\frac{1}{2}$. of those Leagues, to make one Deg. in the Meridian:

N 3

Which

Which measure I have reduced for the generall good into our *English* proportion, drawing it forth in this manner; 3. Barly Cornes to make one Inch, 12. of those Inches to yeeld one foote, and 10 of those teete, 4. Inches, one Barly corne, and one third part of one Barly Corne, to make one Staves length, one thousand of those Staves to make one Myle, three thousand to yeeld one League, and 20. of those Leagues to make one Degree either in the Meridian or Equinoctiall: Here you have my way of projecting, which if you please to make tryall by way of Reduction; I am certaine you shall find it most exactly correspndent in all poynts to the *Spanish* Account, which hath not been hither unto so truly reduced by any Man.

The Table in English measure, according to the Spanish proportion.

Leagues, Myles, and Staves, of the Course or Rombe, which answereth in raising or depressing the Pole one Degree.				Leagues, Myles, and Staves, which you will depart from your first Meridian in raising or depressing the Pole one Degree.			
<i>Course,</i>	<i>lea</i>	<i>M</i>	<i>Sta.</i>	<i>Course,</i>	<i>lea</i>	<i>M</i>	<i>Sta.</i>
N.	20	0	000	N.	0	0	000
N by W.	20	1	142	N by W.	4	0	000
NN W.	22	0	428	NN W.	8	0	857
N W by N.	24	0	000	N W by N	12	0	999
N W.	28	0	857	N W.	20	0	000
N W by W.	36	0	000	N W by W.	29	2	828
W N W.	52	0	857	W N W.	48	0	857
W by N.	102	1	714	W by N.	100	1	714

Certaine

*Certaine Rules of Reduction, performed by the ayde
of my former Tables, and a little Arithmetick
rightly applied.*

AFTER you have taken heedfull observation of my former Tables which I have carefully calculated, according to the *Spanish* account, which alloweth 17½ Leagues to be one Degree in the Meridian; it followeth most fitly, that you should endeavour to acquaint your selfe with all manner of Rules of Reduction, whereby you will be able upon all occasions (with the helpe of former Tables) most readily to reduce any kind of measure into what other Denomination you desire, as by these following questions is plainly expressed.

*A Rule how to reduce any number of single
Staves into Leagues.*

VW **H**EN you have my certaine Number of single Staves that you would reduce or turne into Leagues: First set downe the given Number, then cut off three of the last figures towards your right hand, which figures so cut or separated from the rest, doth at all times shew you the odde Staves that will happen, because they can never at no time yeeld either Myle, or League, then take the residue of the figures which remaine towards your left hand, and divide them by 3. and the quotient will yeeld you the Leagues desired; if any thing remaine upon the Division, they are ever Myles, and your remainder will never exceed 3. As for Example.

First Question of Reduction.

Demand, what number of Leagues will be contained in the summe of 6974895. Staves in length.

Manner

	x3	lea.	mi.	Sta.
<i>Manner of Worke,</i> — 6974	895	2324	2	895
	3233			

Here in this Question according to the manner of worke which you see performed, you may observe that 895. were first cut of with a downe right dash of the Penne, from the given Number, which sheweth the odde Staves as before, then the residue of the Figures towards the left hand, namely 6974. being divided by 3. the quotient doth yeeld 2324. leagues and 2. remaining upon the Division, which sheweth that two odde myles happen upon this Question, and so you cannot but plainly perceive, that 2324. leagues, two myles, 895. Staves, answereth the former demand.

A Rule how to reduce any Number of single Staves, into Degrees of Longitude, according to any Paralell.

WHen you have any Number of Staves given, that you would turne into degrees of Longitude, according to any Paralell or Latitude that you desire: First, set downe the number of Staves, then search in my Table of Longitudes calculated in single Staves, how many will make a degree in that Paralell, which must be your Devisor to divide the summe given, and the quotient will shew you the degrees desired; if any thing remaine upon the division, they are ever the odde Staves, which will not amount to make a Degree; therefore you may reduce them most readily into Leagues and Myles, as I shewed you before.

Second Question of Reduction.

I Demand, how many degrees of Longitude, 745948: single Staves, will yeeld in the Paralell or Latitude of 25. deg. 00. min.

Here

Heere in this question, you must first set downe 745948. the number of the Staves given, then search in my Table of Longitudes calculated in single Staves, how many will make one Degree in the Latitude of 25. deg. 00. min. and you shall finde 54409. with which summe, if you divide 745948. there commeth into the quotient 13. which are the Degrees of Longitude desired, and there remaineth upon the Division. 38631. which are single Staves, that will not make one Degree of Longitude in the aforesaid Latitude: therefore you may reduce them into Leagues, Miles, and Staves, as I have shew'd before; and they will yeeld you, 12. leag. 2. miles, 631. Staves. As for Example.

Manner of Worke.

	138	
	54409	
	201851	llc. m. stav.
	745948	13. 2. 631.
	54409	
	38631	
		2863115
		32

A Rule to reduce Degrees of Longitude, in any Paralell or Latitude, into single Staves.

First, set downe the Degrees which you would reduce into Staves, then search in my Table of Longitudes, in single Staves, how many answer to one Degree of Longitude in that Latitude which you desire: multiply that summe by the Degrees, and you have the Staves. As for Example.

Third Question of Reduction.

I Demand, how many single Staves are contained in 19. Degrees of Longitude, in the Paralell or Latitude of 50. Deg.

()

Manner

Manner of Worke.

$$\begin{array}{r}
 38567 \\
 19 \\
 \hline
 347103 \\
 38567 \\
 \hline
 732773
 \end{array}$$

Here in this Question, you may perceive by the manner of worke, that 38567. are the single Staves which make one Degree of Longitude in the Paralell or Latitude of 50. Deg. which Staves being multiplied by 19. Degrees, will yeeld 732773. which are the single Staves containd in 19. Degrees of Longitude in the Latitude of 50. Degrees, which answereth the question.

A Rule to reduce any number of Leagues into single Staves.

Vhen you would reduce or turne any certaine number of Leagues into single Staves. First, set downe the number of Leagues given, then cut off with a dash of your Pen, the three Figures which are next towards your right hand, and multiply the residue which remaine towards your left hand by 3. to the Off-com or Product, adjoyne those three Figures, which you did formerly cut or separate from the rest, and that totall Areare, is the Staves desired: As for Example.

Fourth Question of Reduction.

I Demand, how many single Staves are containd in 945638. Leagues.

Manner of Worke.

$$\begin{array}{r}
 945638 \\
 31 \\
 \hline
 2835638
 \end{array}$$

Here

Here you may perceive by the manner of Worke, that after the three Figures towards your right hand were cut off, the residue, namely, 945. was multiplyed by 3. and it yeelded 2835. to which Off-com or Product, the 638. which were formerly separated with a dash of the Pen, being adjoyned, the totall Areare appeareth to amount to 2835638. which are the single Staves desired. When the Leagues which you are to turne into single Staves, doth not amount unto one thousand, then onely multiply the summe given by 3. and to that Product adjoyne three Ciphers, and the totall Areare which ariseth, is the thing desired. As for Ex-
ample.

Fifth Question of Reduction.

I Demand how many single Staves are containd in 978 Leagues.

Manner of Worke.
$$\begin{array}{r} 978 \\ \times 3 \\ \hline 2935000 \end{array}$$

A Rule to reduce or turne the whole Circumference of the Terrestiall Globe, according to any Paralell or Latitude, into Leagues, Miles, or Single Staves.

When you would reduce the whole Circumference of the Globe into any measure that you desire; first, observe the Paralell or Latitude, wherein you desire to know the quantity of Leagues, Miles, or Staves, that should surround the whole body, and then search in my Table of Longitudes, calculared in single Staves, how many will yeeld one Degree in that Paralell; which summe, if you multiply by 36. and to the Off-com adjoyne one Cipher, that totall Areare sheweth the single Staves containd in the whole Circumference

ference of that Paralell; which you can reduce into Leagues, and Miles, as I have formerly shewed you, which will appear most plainly by the following Example.

Sixth Question of Reduction.

I Demand, how many Leagues is containd in the whole Circumference of the Terrestrial Globe, according to the Circular Paralell, in the Latitude of 50. Degrees.

Manner of Worke, —

38576	
36	
331456	
115728	
13887360	



2 2	360	Lea. Mil. Stave.
22887	360	4629. 0. 360
3332		

Here in this Question, you may perceive by the manner of worke, that 38576. single Staves, yeeldeth one Degree of Longitude, in the Latitude of 50. Degrees, which Staves being multiplied by 36. and to the Off com adjoyning one Cipher, the totall product amounteth to 13887360. which are the single Staves that will surround or compasse the whole Globe, in that Paralell of 50. Deg. Which Staves, you may see being reduced into Leagues, doth yeeld 4629. Leagues, 0. Min. 360. Staves, which are the Leagues and Staves containd in that whole Circumference, and answereth the Question in those sorts of measure.

If you would know the Miles and Staves that will answer to this whole Circumference of the Globe, onely take the former totall Areare, and cut off with a downeright dash of your Pen, the three Figures towards your right hand, and you

you have your desire ; for the 3. figures cut off from the rest are ever the single Staves, and the residue remaining towards your left hand are the Myles, As for Example, 1. mil. 36. Staves, 13887|360.

A Rule to find the Diamiter of any Paralell, having the whole Circumference first given either in Leagues, Miles. or single Staves.

VHen you would finde the Diamiter of any circular Paralell that is described upon the Terrestiall Globe, after you have observed the Latitude or bredth, and how it is Scituated, in respect either of the Pole or Equinoctiall : Then take this course, Multiply the whole Circumference by 7. and divide that product by 22. the quotient will answer your desire ; As for Example, wee will of purpose take in hand to find the Diamiter, to the Paralell of 50. deg. which was our first and last foregoing Question of Reduction ; because, after we have found that Diamiter, by the same Diamiter. we will finde againe the Circumference, and so shall need no farther illustrating the matter, in regard if you judiciously observe the concurring of the two circumferences severally found out, it will satisfie you for the surenesse and sufficiency of the worke in all other Paralels, being ever performed by the same manner as is already mentioned.

A Question of finding the Diamiter of any Paralel Circle.

I Demand, how many single Staves lengths is contained in the Diamiter of the Circular Paralell, Scituated in the Latit. of 50. deg. from the Equinoctiall.

Here in this Question, you must first turne the whole Circumference of the Paralell in the Latitude of 50. deg. all into single Staves, as hath beene formerly shewed, and it will amount to 13887360. which summe you must multiply by 7.

03

and

and the product is 97211520, which divide by 22, the quotient is 4418705, and 10, remaining upon the division, which is a Fraction of one Stave: The Question being answered in single Staves, which if reduced into Leagues yeeldeth 1472. lea. — 2 mil. — 705. Sta. $\frac{10}{11}$ the true length of the Diamiter desired.

How to finde the whole Circumference of any Circular Paralell by the Diamiter.

I Demand the whole circumference of the Paralell Circle in the Latitude of 30. deg. the Diamiter being found as before, to be 1472. leag. — 2 mil. — 705. Sta. $\frac{10}{11}$.

Here first, reduce 1472. lea. — 2 mil. — 705. Sta. $\frac{10}{11}$ the length of the Diamiter into single Staves, it maketh 4418705 which summe now multiply by 22, and it yeeldeth 97211520. to this totall product adjoyne 10. the Numerator of the Fraction, and then it maketh 97211530. divide this summe by 7. the quotient sheweth 13887360. which is the whole circumference of the circular Paralell, at the Latitude of 30. deg. the thing desired, and being reduced into Leagues maketh 4629. lea. — 2 mil. — 360. Stav. agreeing with the former rule of Reduction.

A Reason of the Worke.

THe Reason why this worke is thus drawne forth in searching for the true Diamiter of any Circle, is in respect, that all manner of Circumferences are more then triple the Diamiters, by a certaine fragment or small part, which in the neereft calculation that I could ever find out, was more then $\frac{10}{11}$ of the same: Now take the neereft rationall proportion, and you will find it is as 22. is to 7. in my Iudgment not possible to be drawne neerer.

These Rules of Reduction, which are formerly explained, being well observed by the judicious Practitioner, I am certaine

caine, will yeeld him such satisfaction in the facile performance of divers matters, which heretofore were most obdurate and doubtfull with the utmost of his endeavours to find out, that he cannot but yeeld some gratefull acknowledg^{mt} to the Author of this worke, as the Instrument of ease to many of his conclusions.

How to find all manner of Meridionall distances, according to the Courses which you are to Saile, in proportion as they are described upon the Globe.

After you have sufficiently enformed your selfe with the wayes of Reduction, it is very proper that you should in the next place apply your selfe to find out, how farre you shall be separated from your first Meridian, in sayling upon any course, according to the truth discovered by the Globe: For I am most certaine, that the disproportion which hath hitherto bene commonly used amongst Sea-men, in drawing forth their Meridionall distance, (according to the Plaine Chart,) hoping that it would agree or concur with their Latitude found by observation, hath bene the chiefe cause of such grosse mistaking the matter, that many times they have had their expectations deceived above 300 hundred Leag. in sailing not above 14 or 15 hundred: For in respect all the Lynements and parts of the plaine Chart, which hath in all Paralels, equall degrees of Latitude and Longitude, are in generall so grossely false, you must ever expect such preposterious conclusions ingendred by his directions, in the prosecution of long Voyages; wherefore, if you please with patience, first to allow the truth of the premises, I will then give you directions by the helpe of my former Table, how you shall finde the true Meridionall distance according to the Globe, upon what Course soever you shall Saile; or in respect of the distance betwixt any two places howsoever Scituated, which I will manifest and make plaine unto you by resolving
of

of these following Questions, desiring that you would ever have a speciall regard to your Meridionall distance as the maine poynt in Navigation, that will not faile to produce the certaine truth, if with judgement you draw your poynt of Longitude, most exactly to concurre with your daily observation of the Latitude.

First Question, of Meridionall Distances.

There are two places to the Northwards of the Equinoctiall, one Scituated in the Latitude of 60. deg. the other in the Latitude of 40. deg. and they differ 20. degrees of Longitude in the Equinoctiall, according to the intersection of their severall Meridians. Now I demand, if you were to saile betwixt the aforesaid places, by the most direct course that was possible to be found out, how many Leagues you would allow the Ship to be separated from your first Meridian, according to the Globe.

Here in this Question, first turne the 20. degrees of Longitude distant in the Equinoctiall into Leagues, and they will yeeld you 400. then take 20. degrees, in the Paralell or Latitude of 40. deg. and turne those degrees into single Staves, as formerly I have shewed, and they will yeeld 919240. then turne 20. deg. of Longitude in the Paralell of 60. deg. into single Staves, and there will arise 600000. which two summes containing the single Staves according to each Paralell, adjoyne into one summe, and then it will yeeld 1519240. Now the halfe of this totall sheweth the Meridionall distance in single Staves, that is contained betwixt the aforesaid places according to the proportion of the Globe, which if you turne into Leagues by reduction, will yeeld 253. leag. — 0. mi. — 620. Staves, as appeareth by this Example.

Manner of Worke.

Single Staves contained in the Paralel of 40°. --- 919240
 Single Staves contained in the Paralel of 60. --- 600000
 Both summes adjoynd into one, will make --- 1519240
 The halfe summe in single Staves or distance Meridionall desired. } 759620

You may observe by this Meridionall Question, what Error in your Longitude the plaine Chart would have lead you into; if according to his directions you should have drawne forth your Meridionall distance: For that instrument having in all Paralels or Latitudes, equall degrees of Latitude and Longitude, must of necessity have yeelded you the distance Meridionall, according to the degrees of the Equinoctiall, which sheweth 400. leagues, then which you see most apparently nothing can be more contrary to the truth of the Globe, therefore the intelligent Artist will not endure to follow such directions, for whose sake I have taken thus much paines to prescribe these new Rules, rendring (if rightly used) upon all occasions the most infallible truth.

Second Meridionall Question.

I Demand, if you should saile 12. degrees West, in the Latitude of 80. deg. and then was enforced to Steere due South, untill you come into the Latitude of 50. deg. how many Leagues you would be then distant from your first Meridian.

Here in this Question you have no more to doe, but onely to turne 12. deg. in the Paralell of 80. into Single Staves, and it will yeeld 125028. which summe if you reduce into Leagues, doth make 41. lea. --- 2. mil. --- 28. Staves. And now in regard it is supposed, that you are in the Paralell of 50. degrees, having kept the former Course, turne 12. deg. of that Paralell into single Staves, and it will yeeld 462804.

p

which

which if you reduce into Leagues, doth yeeld 154. lea. — 0. mil. — 804. Sta. which answereth the Question, and is the true distance Meridionall in that Paralell, according to the Giobe.

Third Meridionall Question.

I Demand, in the Latitude of 40. Degrees, how many Leagues one degree of that Paralell is lesse, then one degree of the Equinoctiall.

Heere in this Question, you must turne to my Table containing the Difference of Longitude, and there seeke the Latitude of 40. deg. and the three next Columns towards your right hand, will shew 4. Leagues, 1. Myles, and 38. Staves, which answereth the Question; for so much is one degree of Longitude in that Paralell lesse, then one degree of the Equinoctiall.

Fourth Meridionall Question.

T Here are two places in the Paralel or Latitude of 60. deg. and by the Equinoctiall are Distant each from other 20. degrees, or 400. Leagues: Now I demand, how many degrees and Leagues the aforesaid places are distant from each other, according to their Paralell in 60. degrees.

Here in this Question, search first in my Table calculated in single Staves, how many answer to one degree of Longitude in the Latitude of 60. degrees, and you will find 30000. which Staves, Multiply by 20. the degrees in the Equinoctiall, and they will yeeld 600000. which answereth the Question in single Staves, and being reduced into Degrees and Leagues, as I have formerly shewed you, will produce 20. degrees of that Paralell, or 200. Leagues the proportion desired.

Fifth

Fifth Meridional Question.

THERE are two places, one lying in the Latitude of 40. degrees, the other in the Latitude of 60. degrees, and are distant 15. degrees of Longitude, by the degrees in the Equinoctial.

I demand, how many Leagues are contained betwixt the Meridians of those two places, according to their severall Parallels.

Turne one degree in each Paralell into single Staves, and them multiply their products by 15. the deg. of the Equinoctiall, and you have the single Staves contained in each Paralell, which you know how to reduce into Leagues, and in this Question, the Paralell of 60. deg. will yeeld you 150. leagues, and the Paralell of 40. degrees will yeeld 129. leagues — 2. mil. — 430. Sta. which are the true distances in each places Paralell, according to the proportion of the Globe.

There are infinit other Questions which you may daily performe by the helpe of my former Tables, with so much ease that you cannot allow the use of the plaine Chart, (to exceed them in that poynt) yet I am certaine you cannot now choose, but perceive how farre the Conclusions wrought by the former Directions doth excell the plaine Chart, which you see apparently hath need of Crutches, being lame in all his Limements.

How to finde the Course or Point of the Compasse, when you are to Sayle in any Paralell, according to the Distance taken by the Arch of one of the greatest Circles.

HAVING thoroughly acquainted your selfe with the true use of my former Tables, the rules of Reduction, the true quantity of Leagues, Myles, and Staves lengths, which

you must Sayle upon all Courses, before you raise or deresse the Pole one degree; as likewise how much you shall varie in each degree from your first Meridian, the reason of the measure drawne from the *Spanish* accompt, and all the matters in generall formerly explained, then if your Course be according to any paralell, you may proceed to find out the poynts of the Compass by which you must steere according to the plaine of the great Circle extended, betwixt any two places so Scituated; but if the two places differ much in Latitude as well as in Longitude, then it is most vaine to endeavour to prosecute your Course by the Compass according to the plaine of that great Circle extended, as shall be at large explained, where I will shew you how to order your affaires according to such manner of Courses; if they differ but a small matter in Latitude, then your paralell direction serveth.

A Paralell Question.

I Demand, the Course and distance according to the Arch of one of the greatest Circles extended, betwixt the Island called by the name of *Shetland*, being one of the Isles of *Orkney*, which is Scituated in the Latitude of 60. deg. to the Northward of the Equinoctiall, and hath 21 degrees of Longitude, and the great Island called *Desolation*; which lyeth in the way as you saile to *Danes Straights*, and is also Scituated in the Latitude of 60. deg. of North Latitude and hath 330. deg. of Longitude.

To prosecute your Course in this Question, and other of like Nature, according to the position of each severall Angle, that the great Circle extended betwixt the aforesaid places produceth, I know will prove so troublesome, that the Mariner I am certaine will not endure such directions, and although he should take such paines, the profit arising will be but a poore reward, in regard the Ship will not nor cannot be constrained to observe them in her Course through the Sea:
Where-

Wherefore leaving such nice conclusions, to the Practitioners in quiet studies on the Land, I will shew the Mariner a facile way how hee shall find out a Course or poynt of the Compasse according to the distance discovered by the plaine of the great Circle extended; and yet in the whole Course shall not alter the poynt of the Compasse above thrice, which hee may very easily constrain the Ship to performe, as shall be now explained according to the Question propounded.

First then, to resolve the Question, you must find the true distance betwixt the Ile of *Sholand*, and the Island called *Desolation*, according to the Arch of a great Circle, as hath bin shewed heretofore, which will appeare by worke, is 490 leagues; Now turne the distance of degrees that is contained betwixt the aforesaid places into Leagues, as hath likewise beene formerly shewed, and there will arise 510. from which if you subtract 490. the distance by the great Circle, there remaineth 20. leagues, which sheweth that you will make your way so much shorter, then if you should saile by your East and West Paralell. Now then turne the Leagues found by the extention of the great Circle into single Staves, and it will yeeld 1470000. then reduce the 510. Leagues, the distance in the Paralell, and it yeeldeth 1530000. single Staves, Now suppose you were beginning to shape your Course from the Island of *Sholand*, to saile to the former Island called *Desolation*; you may in the first place very plainly perceive that if you should perceive, that if you should saile any thing to the Southward of your Paralell, you must needs make your way longer, in regard all Paralels betwixt your Latitude of 60. deg. and the Equinoctiall retaine a bigger proportion in respect of the Meridian; but all Paralels contained betwixt your Latitude and the Pole yeeld a lesse proportion; therefore you may conclude according to reason, that you must ever shape your Course to the Northward of your Paralell, if you intend to saile according to the plaine of the great Circle extended: Now then being assured you are to saile to the North-

ward of your Paralell, you must find in this manner the greatest poynt of North Latitude that you are to touch; at first, turne all the degrees of the Meridian which are contained betwixt your Latitude of 60. degrees, and the Equinoctiall into single Minutes, which you may easily performe at all times, if you multiply the degrees of Latitude by 60. the product yeeldeth your desire; As in this Example 60. d. of Latit. multiplied by 60. will yeeld you 3600. which are the single Minutes desired: Now apply the backe rule of proportion in this manner, saying, if 1530000. the Single Staves contained in the distance by the Paralell, yeeld 3600. minutes of the Meridian, what shall 1470000. single Staves, the distance by the Arch yeeld, which if you worke according to the reversed rule of proportion, will produce 3746. minutes of the Meridian, which minutes if you divide by 60. the quotient sheweth 62. deg. and 26. remaining upon the division which are minutes; therefore you may now conclude, that the poynt of your greatest North Latitude which you must touch at in this Question, is 62. deg. 26. min. Now to find the poynts of the Compasse which you must direct your course by, according to the plaine of the great Circle extended; First divide 1470000. the single Staves in the distance by the great Arch into three equall parts, which doth represent the three severall poynts of the Compasse by which you are to saile, and in this question you will find the one third part is 490000. Staves, then take the odde degrees and minutes of Latitude, which exceed your Paralell of 60. degr. namely, 2. deg. 26. min. and turne them into minutes, and they will yeeld you 146. Now apply the plaine rule of proportion, saying, if 146. minutes of the Meridian yeeld 490000. single Staves upon the course, what shall 60. Minutes, being one Degree of the Meridian yeeld, and the worke will shew you 201369. Staves, which if you reduce into leagues amount to 67. leagues, and 369. Staves, which are the Leagues and Staves which you must saile upon the Course before you shall raise the Pole one degree: Now then

then, if you repaire to my Table which sheweth the Leagues, Myles, and Staves, which you must saile upon any poynt of the Compasse to raise the Pole one degree, and there make application, searching out what poynt will come the nearest in his proportion to 67. lea. 369. Sta. you will find it is W, N W. $\frac{1}{2}$. part of one poynt Westerly, upon which Course you must Saile 490000. Staves, which will raise the Pole, 2^d. 26. min. and toucheth the Paralell according to the poynt of your greatest Latitude formerly found, concluding one poynt of the Compasse by which you are to saile, and yeelding you the one third part of your distance to be expired; Now you must saile 490000. Staves, which is one other third part of the distance due West, keeping your selfe exactly in that Paralell of 61. deg. 26. min. untill that third part be also expired, then in regard your first course was W, N W. $\frac{1}{2}$. Westerly, you must saile 490000. Staves W, S W. $\frac{1}{2}$. Westerly, untill you find by your observation that you are come againe into your first Paralell or Latitude of 60. deg. and then is this third part which is the last of the three also expired, and now you may be most confident that your Ship is close aboard the great Iland called *Desolation*, which is the place you were to saile unto; and you have made your Course shorter by 20. leagues then it would have beene, if you had sayled according to the direction of your East and West Paralell; besides the great ease and helpe which you have according to this kind of sayling, to accompt your Ships way through the Sea by your daily observations, in regard it plainly appeares that you shall raise and depresse the Pole upon this whole course neare upon 5. deg. of Latitude, I know the ingenious Artist will quickly discerne there is sufficient reason to satisfie (it is worth his labour) to prosecute his Paralell courses, according to these plaine and easie directions, which cannot in any kind seeme obscure or darke to his understanding, unlesse perchance he should not be over-well acquainted with *Regula reversa*, or the backe rule of Three, which indeed is a most excellent Rule, both to resolve divers questions of Navigation.

vigation, as also to produce the infallible truth in divers other practises: Therefore, and because I am most certaine, that very many Sea-men, take little notice of so necessary a Rule, I will briefly shew you the reason of the proportion, (for want of which understanding I doubt many of you have omitted the manner of Worke.) First then, you must take notice that in the plaine Rule of proportion (or Three) the first number and the last beare a plaine proportion, in respect of each other, that is to say, if the first number be bigger it yeeldeth the greatest proportion; if least, then the least proportion: As for Example, (If 9. give 6. then 3. will yeeld 2) or (if 3. give 2. then 9. will yeeld 6.) But in *Regula reversa* the proportion doth not so answer; for if you say by that Rule (If 9. give 6. then what shall 3. it will yeeld you 18.) or (if 3. give 18. what shall 9. it will yeeld you 6.) I will explaine the matter and manner of worke by this casie Question.

*A Question of the reversed Rule
of Three.*

I Demand, if 9. men in 6. dayes will compleatly ridge a certaine Pinnace, in what time shall 3. men ridge the aforesaid Pinnace.

Now, if you should apply the plaine Rule of Three, and say if 9. men require 6. dayes, what shall 3. men require, it will yeeld you 2. dayes, which is a matter contrary to all manner of reason, that three men should ridge the Pinnace in lesse time then 9. men; therefore you may perceive the plaine Rule of Three is not capable to resolve this Question, but if you apply the reversed Rule, saying, if 9. men require 6. dayes to ridge the aforesaid Pinnace, what time shall 3. men require, and it will yeeld you 18. dayes, which is the truth desired.

Man-

Manner of Worke.

IF 9. men require 6. dayes, what shall 3. men require?

$ \begin{array}{r} 9 \\ \times 6 \\ \hline 54 \end{array} $	$ \begin{array}{r} 54 \\ \div 3 \\ \hline 18 \end{array} $
--	---

Here you see, by the manner of worke used in the versed Rule, that 9. the first number being multiplied by 6. the second number doth yeeld 54. which being divided by 3. the last number, the Quotient giveth 18. which are dayes; and answereth the question. Knowing the excellent Conclusions performed by this Rule, I could not but give the Sea-men this little taste, which I am certaine hath the true relish, and perchance may stirre up their appetites with a longing desire, freely to feast on such faire and pleasant fruites.

*The Ooder to be observed in your Sayling betwixt any
two places that are Scituated in severall Latitudes and Longitudes.*

WHen you are to sayle betwixt any two places assigned, that differ both in Latitude and Longitude, after you have found the true distance according to the Arch of a great Circle extended, you must not imagine to prosecute your course according to the position of each severall Angle, that the Ship must be constrained to performe, if you should sayle by the plain of that great Circle so extended: for first, you will gaine so small a matter in the shortning of your way, that it will not be worth looking after. And then must be enforced to steere (point blanke) as I may tearme it with your place assigned, concluding your Latitude and Longitude in one minute, which we all know (that have experience at Sea) is not the best course to be observed; for if we should misse the least matter eyther in observation, or accompting our Meridionall distance. In sayling to

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alone

alone Iland in the Ocean Sea, wee might quickly with our over nice Conclusions, shoot beyond the Marke; which would redound more to our discredit, then the profit of prosecuting our course, could ever promise us.

Therefore, when you are to sayle according to such distances: first, finde out the true quantity of Leagues, according to the great Arch extended, which Leagues turne into single Staves; then consider the Latitude of both places, subtracting the lesser from the greater; if both places be situated eyther to the North-ward, or South-ward of the Equinoctiall, and the remainder will shew you, how many Degrees and Minutes, you must raise or depresse the Pole in in your whole course. But if one of your places should lye to the Southwards off the Line, and the other to the Northwards, then adde the lesser Latitude to the greater, and the Off-com or totall summe, sheweth how many Degrees and Minutes you will raise or depresse the Pole, upon that whole Course; which Degrees and Minutes so found out, turne all into single Minutes, then take the Minutes contained in one Degree of the Meridian, which are ever 60. with which summe, multiply the single Staves containd in the distance found, by the great Arch; and then take the Product, and divide it by the single Minutes, contained in the difference of your Latitude, and the Quotient will shew you how many Staves you must sayle, before the Pole shall be raised or depressed one Degree: which Staves, if you reduce into Leagues, and then compare those Leagues with the Leagues answering in my former Table, to each point of the Compass, in raising the Pole one Degree; you will finde the point of the Compass by which you are to Sayle, as shall appear by this Example.

Question.

I Demand, the Distance and Course by the point of the Compass that you must Steere upon, in sayling betwixt the
Head-

Head-land in the West of *England* called the *Lyzard*, lying in 50. Degrees of North-Latitude, and in 16. Degrees of Longitude; and the Iland called the *Barbadoes* in the West-Indies, being situated in 13. Degrees of North Latitude, and in the Longitude of 313. Degrees.

Here in this Question, first finde out the distance by the great Arch, which will appeare to be 1280. Leagues; and being turned into Staves, doth yeeld 3840000. then subtract 13. deg. the lesser Latitude, from 50. deg. the greater, there remaineth 37. degrees, which turned into single minutes, will yeeld 2220. Now if you take 60. minutes, which make one degree of the Meridian, and multiply 3840 000. the Staves contained in the distance by the great Arch, the Product will amount to 230400000. Staves; which Staves, if you divide by 2220. the minutes that arise in the 37. degrees difference of Latitude, the Quotient sheweth you 103783. Staves, and 1740. remaining upon the division, which is a fraction of no consequence: Therefore, if you turne 103783. Staves into Leagues, it yeeldeth 34. leag. 1. min. 783. Sta. Which sheweth you, that you must saile so much upon your Course, before the Pole shall be depressed one Degree. Now then if you repaire to my Table, which giveth the Leagues upon all points of the Compasse that you must saile, before you raise or depresse the Pole one Degree, and there observe which of them answereth nearest to 34. leag. 1. min. 783. Staves, you will finde S W $\frac{1}{4}$. point Westerly, which is the point of the Compasse, which runneth right upon the Iland, according to the Rumb extended betwixt the *Lyzard* and the *Barbadoes*. But you know, in sayling betwixt these two places, we haule at first a farre more Southerly Course, in regard we would get as much benefit as possible of the Trade-winde (as we tearme it,) which ever bloweth betwixt the North and East, when you are neare the Tropickes, and then we haule away more Westerly; yet still being carefull to get into our Latitude, 50. or 60. Leagues short of the Land, that we may be sure not to over-shoot the place:

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which indeed is the best & surest way of sailing betwixt the aforesayd places. For which manner of proceeding, we have experience, for our infallible & uncontrollable Tutor, which did not dwell all his dayes within the confines of a quiet Closet; for from thence there could never as yet be drawne forth such directions. Therefore, the industrious endeavors of the judicious Practitioners in the famous Art of Navigation, must reape as in all right, & grateful acknowledgmet of their great attempts, for finding out both this and divers other matters, which no Studie-Rules could ever reach so farre, to parallell their experimentall Conclusions. Therefore, we may justly joyne Art and Experience, as the two equall Sisters, which made the wreath of Renowne, that bindes the Browes of all generous and worthy Navigators. But to speake a word or two more concerning the former worke contained in this Chapter: You may understand, that the point of the Compasse may also bee found out, according to the distance betwixt any two places, by your Meridionall proportion, as we will prove by the former Question, in this manner.

First, observe all the Degrees of Longitude, contained betwixt the *Lizard* and the *Barbadoes*, and you will finde they are 63. deg. Which Degrees, turne into single Staves, according to each places Paralell, and there will arise in the Paralell of 50. Degrees 2429721. Staves, and in the Paralell of 13. deg. there amounteth 3683106. which two summes contayning the single Staves, according to each places Paralell, adjoyne into one summe, and it will make 6112827. Staves. Now take the halfe of this last summe, which is 3056413. and it sheweth you the single Staves contained in your Meridionall distance according to the Globe; therefore divide these Staves by 37. Degrees, the difference of your Latitude, and the Quotient will yeeld you 82605. Sta. which being reduced into Leagues, doth yeeld 27. leagues, 1. mile, 605. Staves. And now if you repaire to my former Table, and there search what Meridionall distance answereth to 27-leag. 1. mile, 605. Staves. You will finde, that
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S. W. $\frac{1}{2}$. poynt Westerly, answereth your desire, thus you have two infalliable wayes to find out the poynt of the Compasse according to all distances; if you desire a farther reason of this manner of work, you must understand it is onely drawne forth from the plaine rule of Proportion in both the wayes: For as 37. degrees, the difference of Latitude, is to 3840000. Staves the distance by the Arch, so is one degree of the Meridian to the Course or poynt of the Compasse, which yeelded 34. lea. 1. mil. 783. Sta. which being compared in my Table S. W. $\frac{1}{2}$. poynt Westerly, sheweth the same quantity, then the Meridionall proportion is, as 37. degrees difference of Latitude is to 3056413. Staves distance Meridionall, so is 1. degree of the Meridian to 82605. Staves, which make 27. lea. 1. mil. 605. Sta. and being compared to the Meridionall distance in my Table S. W. $\frac{1}{2}$. Westerly, yeeldeth the same proportion, this is sufficient for those which desire a farther reason of the former worke; and so I will leave this matter to their farther practice, and will now proceed to shew the use and projections of the Crosse-staffe and Back-staffe; and so I will make a full conclusion of this my whole worke.

The Projection of the Crosse-staffe.

THe Crosse-staffe is onely a Geometricall Arch contrived into a straight line upon the graduated Staffe, which when the Crosse is applyed, giveth the content of the (Angle) with as much certainty and truth as the Arch or Quadrant doth, and it is projected or framed in this manner.

You must have a paire of beeing Compasses of a large size, as 12. 14. or 16. Inches; with those Compasses upon a plaine and exact levill board or Table, sweepe an Arch of a Circle something bigger, then a Quadrant, and let his Semidiameter be as bigge as with conveniencie your board or Table will containe, the bigger the better: Now with the same extent that you swept the Circle or portion of the Arch, let one foot in one of the Arches extreames, and with the other

make a small pricke or marke in the same Arch, then take halfe the distance of those two pricks or markes, and make a third marke in the same Arch, then laying a straight ruler to the third marke and the Center, draw a straight line; and so likewise betwixt the first marke and the Center draw a straight line: so shall you have an exact Quadrant or fourth part of a Circle contained betwixt those two Semidiameters: Now extend one of those Semidiameters, to what length your board will permit, as 3. 4. or 5. foote, and from the intersection of the other Semidiameter with the Arch, raise a perpendicular which may runne exactly Paralell, to the Semidiameter extended, and make them equall of one length, then divide your Arch into two parts, drawing a line from the Center through that division, untill it intersect the former Paralell; then divide the halfe Arch into three equall parts, drawing Lines through those divisions to the Paralell as before, and then divide those three parts into other three parts, and those 9. parts each into 3. parts, so have you 18. parts, and those 18. each into 5. so have you 90. parts; now draw lines through each of those divisions, from the Center to the Paralell, as before: And so have you a Geometricall projection, for the making of all sorts of Crosse-staves according to the length of theyr Crosses or Transummies; onely for your more easie understanding, and that you should not mistake when you are to Graduate a Staffe by this projection, observe this Method.

If you would have a large Staffe containing large Degrees, all your Transummies or Crosses must be as large as your projected Quadrant is of capacity to beare, namely the halfe of your 90. Transum may be the length of the Semidiameter to the intersection of the Arch, but longer it must never be, for that is the greatest and largest degrees, that any Transum can shew with truth upon the largest and longest Staffe that such a projection may produce, but for the other Transummies or Crosses, namely your 60. and 30. will have degrees large enough, if your 60. Transum be one halfe the length of your 90. and

90. and the 30. one halfe the length of the 60.

When you have a Staffe to graduate, and that you have appointed the length of his Transums according to your mind, remember alwayes to take the exact halfe of each Transum, and draw a Paralell to your extended Semidiameter containing that distance: And observe, how that Paralell intersecteth each line drawne through each division of the Arch, and they will be the degrees of the Angle made by your Crosse in observation, in all respects equal to the degrees of a Geometrical Arch, which is the matter desired; and is sufficiently manifested, for the capacity of any man that will be the least industrious.

Now a word or two of the reason of this Projection, and so I will proceed to shew you how to handle him at Sea, to gaine the Altitude either of Sunne or Starres: The reason of this projection may best be drawne from the consideration of a rightangled *Isocheles*, for when your Crosse of 90. deg. intersects that degree upon the graduated Staffe, your Crosse is the subtending side or Hypotenusa, and your two visuall lines, are his containing sides, namely the Line intersecting the Horizon, and your Zenith perpendicular; and the Angle intersected by those two lines falling or joyning with your Eye, and the Center of the Staffe, is a right Angle containing 90. deg. Now from this I gather, if any Angle at the Center of the Staffe must grow more accute or Sharpe, it must proceed by running or sliding the Crosse farther from my Eye, and not by drawing it nearer, for then I should have my Angle more obtuse or blunt then the right Angle of 90. then which, nothing can be more obsurd, then to measure beyond my Zenith in taking the Altitude of Sunne or Starres; wherefore considering I must slide the Transum forwards, if I observe any body Scituated in the Heavens of lesse Altitude then my Zenith, and that my Angle from the Center of the Staffe, and my Eye, will grow more Accute or Sharpe, I perceive my rightangled *Isocheles* is changed into a rightangled *Scalenum*, and that my Crosse is now the perpendicular line
falling

falling from the Body observed, and intersecting my visuall Line with the Horizon at a right Angle, and that my other visuall Line extended to the Body observed, is the Subtending side, or *Hypotenusa* of that Angle; Therefore, I finde the Lines drawne through an Arch exactly divided, are onely visuall Lines of the Angle contained, and that a Crosse may so be fitted upon a Staffe, to intersect each severall visuall Line with a right angled *Scalenum*, untill my visuall Lines containe a right Angle, and the Crosse be the subtending side, or *Hypotenusa*, and then I have a right angled *Isosceles* as afore; he that can draw forth his Imaginations more lively concerning this matter, I freely give him leave, &c.

How to observe the Altitude at Sea, with the Crosse-staffe.

VWhen you would finde the Altitude of eyther Sunne or Starre, by the ayde of your Crosse-staffe, completely fitted with his Transummes, take your graduated Staffe, and one of your Transummes or Crosses, which is most apt or fit for the Altitude desired; as if it be any great Altitude, your 90. Crosse, if a smaller your 60. Crosse, and if the Body to be observed be neere the Horizon, then your 30. Crosse.

As for Example. Suppose you were coming in for the *Sleeve*, and would observe the North-Starre, take your graduated Staffe, and because the Altitude is none of the greatest, imploy your 60. Transum or Crosse, thrusting your Staffe through his Socket, and then place the end of your Staffe, which is the Center to your 90. Transum, in orderly sort; joyning it to the corner of your right Eye, winking with the other, then slide the Crosse too and fro, untill you can see onely the Center, or middest of the Starre, equall with the upper edge of your Transum, and that at the same instant you perceive the lower equall, or intersecting the Horizon; which when you have found in most exact manner, rest from farther labour:

labour: and onely looke where the nearest plaine edge of the Crosse fallerth or cutteth in your graduated Staffe, which Cōclude according to the nūber sofound, is the Angle contained, or altitude of that Body observed. In the same sort, you may finde the Angle or Altitude of all Bodies seituated in the Heavens, with your graduated Staffe, and the Transums or Crosses rightly applied: But I hold, after my Altitude is once greater then 60. deg. your Crosse-staffe applyed according to the former observation, is very difficult and doubtfull to handle without great error; because the Altitude of the Body, and the interseccion of the Horizon, are so farre distant, that your visuall Lines, can very hardly concurre with exact truth in one instant of time; therefore for the observing of the Sunne to the Southwards, your Crosse-staffe is of little use, except you have veynes, or contrive it to observe with the shadow, turning your backe towards the Sunne, as you doe with your Back-staffe, but for all Stars that are not very high above the Horizon, especially if they exceed not 30. degrees, there is no instrument under the Heavens, to bee compared with the Crosse-staffe at Sea, because then his Degrees are so large, that any sensible distance will easily appeare in single Minutes, and with a little labor you shall be in no Latitude of the world, but you shall have divers such Starres come in rule every night, if you will make heedfull observation. Therefore the excellent operation of the Crosse-staffe, can never be disparaged, if rightly applyed.

Of the Back-staffe.

THe Back-staffe, is onely a Quadrant, or fourth part of any Circle divided into 90. Degrees, and it mattereth not which way the accompt of Degrees beginneth to bee numbred, that is, whether your Zenith conclude 90. or the Horizon, for they will come to one matter: if you count the Degrees containd betwixt the two sliding veynes in observation, to be the Altitude according to the cutting of the
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Shadow, and the complement, or that which remaineth without each veine, is alwayes the Zenith distance of the Sunne, according to the Altitude taken, but they are commonly graduated, concluding 90. in the Zenith, which is not the best and readiest way for the Mariners use, but would be more easie (though nothing difficult neyther way) if they concluded 90. in the Horizon. They are projected of divers formes and fashions, but the generall Rule for them all, is, that they containe exactly a Quadrant, or fourth part of a Circle, betwixt your visuall Line that intersecteth the Horizon, and your Zenith perpendicular; but of all Back-staves, I hold the double Arched projection to be the best, and most usefull at Sea, therefore I will here shew how he is framed.

The Projection of the Back-staffe.

THe Back-staffe is so called, because you turne your backe towards the Sunne in observation, and your visuall Line intersecting the Horizon, with the shadow of the Sunne concurring at one instant, giveth the Angle or Altitude desired. Now to frame the Back-staffe with a double Arch, take your large Compases afore mentioned, and upon some plain board or Table, make an exact Quadrant, as hath beene formerly shewed in projecting the Crosse-staffe, containing about 6. or 8. Inches Semidiameter, then be very circumspect to divide that Quadrant into 90. Degrees, as hath been shewed before; Now extend your Semidiameter which intersecteth your Arch, where the 90. Deg. are begun to be numbred, to two or three foot, or at pleasure, and as your materials will permit: Then take the length which you intend to have your Staffe, and draw a Line from the Center, intersecting the Quadrant at 30. deg. of the same length, now sweep an Arch betwixt the end of that extent, and the Semidiameter extended; and so your Back-staffe is finished. If you divide his 30. Arch exactly into deg. and minutes, which is the Arch, whereon in observation you must place your sliding veine with the Sight in it, but the other Arch needeth no more divisions,

divisions, then whole Degrees; because thereon you must place your fixed veine, which will cut the Horizon according to the shadow of the Sunne, and therefore needeth but onely to be placed at any of the whole degrees, as occasion shall require, and the other sliding veine conveying your visuall Line, through the Center of the Staffe, or Horizon veine, will give the Angle or Altitude of all manner of Instruments at Sea that I have met withall, the most easie and plaine.

To finde the Altitude of the Sunne at Sea, with the Back-staffe.

HAVING your three Veines fitted to your Staffe, namely your Horizon veine, with a slit exactly joyning with the Center of the Staffe, and one sliding veine placed upon the 30. Arch of your Instrument, which hath a slit likewise to transport your visuall Line through the Horizon veine at the Center, and one plaine veine placed at any of the degrees in your 60. Arch, as your Altitude shall require. For example, Suppose you would know the Altitude of the Sunne when you are certaine she will be mounted upon her Meridian at least 70. deg. above the Horizon: First, take your projected Staffe, and put on your Horizon vaine, carefully regarding, that the slit and the pricke at the Center concur in one, then take your fixed vaine, and place it upon the 60. Arch, eyther at 70. 80. or 90. but nearer then 70. you must not now place it, because the Angle is like to be about 70. Degrees, and if you should place it at lesse, the 30. Arch will not be capable to resolve the Angle: Therefore here in this Question, suppose you place the fixed vaine with his upper edge, exactly cutting at 80. Degrees in the 60. Arch. Then take your sliding vaine with the slit in it, and place it upon the 30. Arch, moving it higher or lower as occasion requireth untill you finde the visuall Line, transported through the slit of the Horizon-vaine, and that the upper edge of your

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fixed-vaine, casteth his shadow right in the slit of the Horizon-vaine, and that at that very instant your visuall Line intersecteth the Horizontall Circle of the Heavens and the Sea, and so keepe your Instrument, with the ayde of your sliding-vaine. untill you have the Sunne upon her Meridian, or greatest Altitude for that day; then observe in your 30. Arch what Degree and Minute the slit in your sliding-veine cutteth, and accompt all the Degrees contained from the upper edge of your fixed-vaine to that intersection: For the content of the Angle, according to the Altitude of the Sunne taken that day in the afore-sayd place; As in this Example. Admit after the Staffe rectified in all respects as before, that the Sunne upon her Meridian, your sliding-vaine cutteth with his slit just in 10. Degrees of the 30. Arch, therefore you must accompt from the upper edge of the fixed-vaine, placed at 80. Degrees, to ten Degrees the former intersection, and it will yeeld you 70. Degrees, which you may safely conclude, is the Angle or Altitude desired.

And so I will Conclude the whole Worke herein contained, beginning with the Practicke part of Navigation, in working a Ship according to all weathers, and ending with the Practicke in Projecting and using the Back-staffe: Desiring that none out of malice, will seeme over-suddenly to take in hand to mend the matter which I have now writ of, least they shoot short of the Marke, and so loose their Credit by controlling, when they are not able to performe the Lye.

And so Farewell.

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